Pest Management Alliance Final Report

Agreement No. 01-0191C

Development of an Integrated System for Controlling San Jose Scale, Peach Twig Borer and Oriental Fruit Moth in Clingstone Canning and Fresh Shipping Peaches, Plums and Nectarines

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Prepared for California Department of Pesticide Regulation

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ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

The objective of this ongoing project has been to develop an integrated and sustainable pest management program for peaches, plums, and nectarines in California. The research has focused on San Jose scale (SJS), peach twig borer (PTB), oriental fruit moth (OFM), omnivorous leafroller (OLR), and Western flower thrips. Most elements of the Pest Management Alliance (PMA) grant's activities are being presented at grower and pest control advisor (PCA) demonstration plots and meetings. In addition, information developed as a part of this research effort is being disseminated through grower newsletters and on both the CTFA website and the Kearney Agricultural Center website.

Significant research progress was achieved in 2002, which addressed stone fruit pest management throughout California. The purpose of the 2002/2003 PMA project was to augment and expand upon the information gathered in the third year of this program, which compared conventional to reduced risk pest control practices. This year the project further demonstrated and evaluated the efficacy and economic costs of a sustainable pest management program for control of San Jose scale (SJS), peach twig borer (PTB), oriental fruit moth (OFM), Western flower thrips and secondary pests (i.e., katydids and Western spotted cucumber beetle, *Diabrotica undecimpunctata*) in clingstone canning and fresh shipping peaches, plums and nectarines. In addition, this project has studied and documented the biology of these pests and tried to determine the effects of sustained usage of reduced risk materials in pest management programs. Alternative pest control techniques included the use of biological control, pheromones, and reduced risk materials.

Currently, organophosphates (OPs) and carbamates account for the majority of pesticide applications to control stone fruit pests in California. Until comparable reduced risk materials are consistently demonstrated as effective control agents in commercial settings, OPs and carbamates will continue to be used to manage pests. The repeated use of these materials over many years has promoted the development of resistance. The level of resistance, especially by a key pest of stone fruit, San Jose scale, needs to be further evaluated and appropriate means to manage resistance developed. The project is developing a comprehensive pest management program to manage resistance, while at the same time attempting to reduce the need for the overall use of OPs and carbamates to control these pests.

The potential impact of the Food Quality Protection Act (FQPA) may be critical to stone fruit production through the loss of commonly used OPs and carbamates used to control SJS, PTB, OFM, and thrips. Concerns over aquifer contamination and air quality are also affecting current dormant spray use patterns and in-season application of OPs. Therefore, this project has attempted to mitigate the risks of routine OP use through the development of a model integrated system for implementation in canning and fresh market peach, plum, and nectarine orchards throughout California.

Report

A. Introduction

The project was intended to develop and promote a truly integrated and sustainable pest management program for control of the various pest complexes found in stone fruit orchards throughout Central California. Research, demonstration, and educational outreach programs have been conducted in a variety of locations extending from Kern County in the South up to Yuba County in the North. The research included work on SJS, PTB, OFM, Codling moth, Western flower thrips, katydids, and Western spotted cucumber beetle, with no one area of the research promising complete solutions to the problems currently being experienced by the stone fruit industry. Technical challenges, including increasing evidence SJS may be resistant to OPs, growers experiencing unacceptable fruit damage using pheromone mating disruption for PTB and OFM, the influx of secondary pests as a result of implementing reduced risk practices, and grower concerns of economic loss during the transition to instituting reduced risk practices have been barriers to developing a comprehensive integrated pest management program for clingstone canning and fresh shipping peaches, plums and nectarines. The demonstration of commercially available oils, pheromone dispenser systems, and reduced risk pesticides in commercial settings under controlled research methodology is providing actual representations for development of best management practices. In addition, development of a biological control program of augmentation of natural enemies may increase SJS, PTB, and OFM parasitism levels and further reduce the need for pesticide applications. All elements of proposed program have been adapted and implemented in several grower demonstration plots where comprehensive grower education and information dissemination has, and will, continue to take place. In addition, information developed as a part of this research effort will continue to be disseminated in grower and pest control advisor (PCA) newsletters, commodity group and pest management websites, and through the University of California's *Integrated Pest Management Guidelines.*

Materials and Methods (Objectives) [from proposal]

1. Demonstrate and compare the efficacy and economics of pest control techniques that *do not* rely on OP, carbamate, or pyrethroid inputs to control stone fruit pests at "grower participant" sites in six counties throughout California.

The tasks include: a) Demonstrate and compare the efficacy and economics of pest control techniques that *do not* rely on OP, carbamate, or pyrethroid inputs to control stone fruit pests in "grower demonstration" sites in several counties throughout California. Grower demonstration plots have been established in Fresno, Kern, Kings, Madera, Tulare, and Sutter Counties. Reduced risk pest management practices previously developed during the PMA demonstration project will be implemented at these grower sites. Reduced risk practices include: pre-dormant mite and scale damage assessment; OP free dormant application (oil only); use of *Bacillus thuringiensis* (Bt) and pheromone mating disruption for control of PTB and OFM; monitoring of PTB and OFM with pheromone baited traps and shoot strike evaluations; SJS monitoring with double sided sticky tapes, fruit samples, spur samples, and pheromone traps to determine both scale and parasitoid populations and % pest damage at the time of harvest. Monitoring of traps will be accomplished weekly for each site. Mites, katydids, and Western spotted cucumber

beetles will also be monitored and low impact oils or pesticides will be used according to labeled rates. The reduced risk material Success® (Spinosad) will be used to control katydids and thrips. Mite control will be accomplished with the reduced risk material Apollo® (Clofentezine). Western spotted cucumber beetle control will be accomplished with the botanically derived pyrethrum Pyganic and by implementing attractant kill traps with Cucurbitin, a botanical extract. Most of the sites will be compared to a comparable acreage of a monitored commodity treated with traditional OP dormant and in-season sprays. In addition, the costs associated with the relative levels of control in the non-disruptive and conventional pest management programs will be recorded to illustrate the competitiveness of the reduced risk approaches. Several of these sites will also be used for demonstration at grower/PCA field days.

The principal investigators for this project are Walt Bentley, UC IPM Entomologist, and Dr. Kent Daane, University of California Center for Biological Control Entomologist. Assisting in the collection and analysis of data will be Shawn Steffan, UC Staff Research Associate and Janine Hasey, UCCE Sutter/Yuba County Farm Advisor. Assisting in establishment of the demonstration sites will be Gary Van Sickle, CTFA Research Director; Heidi Sanders, CCPGAB Research Coordinator; Harry Andris, UCCE Fresno County Farm Advisor; Janine Hasey, UCCE Sutter/Yuba County Farm Advisor; and Brent Holtz, UCCE Madera County Farm Advisor.

2. Continue to assess the SJS population dynamics and evaluate the potential of natural and augmented biological control.

The tasks include: a) Determine the effect of commonly used OP pesticides, (e.g., Lorsban®, Carzol®) on selected natural enemies of SJS. To test the effect of OP pesticides on natural enemies of SJS, field and laboratory trials will be conducted. Leaf or twig samples will be collected from peach trees treated with conventional OP pesticides to conduct a leaf-dip bioassay. Leaves will be dipped in different pesticides at different percentages of a field-rate dilution. Leaf material will be allowed to dry and then placed in open-ended glass tubes. Parasitoids will be added to the tubes, which will be sealed with organdy cloth. Each day thereafter, the condition (live or dead) of the parasitoids will be determined. The second test will be more complex. At the Kearney Agricultural Center, trees will be sprayed with the same pesticides at label rates and at the appropriate time. Thereafter, leaves will be removed from the trees on different days after pesticide application dates. These "field-sprayed" leaves will be used to bioassay SJS parasitoids as described above (leaf-dip bioassay), which will determine the number of days after field application the pesticides cause mortality of parasitoids. The value of this experiment is that it provides a more realistic determination of a pesticide's effect on parasitoids after a number of days following application, with pesticide degradation progressing under actual field conditions. This work is needed to determine if small amounts of residual pesticides cause mortality of parasitoids, which may explain the poor natural regulation of SJS after orchards receive only one to two pesticide applications (often for moth or mite pests). The principal investigator for this project is Dr. Kent Daane, University of California Center for Biological Control Entomologist. Field and laboratory trials will be accomplished through the efforts of GlennYokota and Rodrigo Kugner, of the UC Kearney Ag Center.

The tasks include: a) continue surveys of stone fruit orchards with and without SJS infestations to determine if resident natural enemies have potential to control pest densities. This will include field monitoring of adults and immatures. This will be accomplished by using a variety of sampling techniques: Pheromone traps, visual inspection of plant material, and double sided adhesive tapes will all help in determining the distribution and abundance of SJS in the field; b) increase populations in insectary colonies of the more common and effective resident SJS parasitoids; c) focus on the population dynamics and interactions of the parasitoids, *Aphytis* and *Encarsia*. To evaluate parasitoid activity, SJS infested squash will be placed in selected orchards for a 2–3 week period, and later the squash will be returned to the insectary to determine parasitoid composition and percent parasitism. Field collections of parasitoids will also be made throughout the season to assess levels of parasitism and distribution within the tree canopy. Attention will be focused on the irregular density levels of *Aphytis* populations from orchard to orchard. Population interactions between *Aphytis* and *Encarsia* will be observed. The appropriate experimental designs and statistical analyses will be utilized to evaluate population information. The principal investigator for this project is Dr. Kent Daane, University of California Center for Biological Control Entomologist. Field and laboratory trials will be accomplished through the efforts of GlennYokota and Rodrigo Kugner, of the UC Kearney Ag Center.

3. Examine the effects of reduced risk materials; i.e., oils and the Insect Growth Regulators (IGRs) Esteem® and Applaud,® on various life stages of male and female SJS to determine the most effective timing for application of the materials.

The tasks include: a) Examine the effects of reduced risk materials, e.g., oils and the Insect Growth Regulators (IGRs), Esteem® and Applaud® on various life stages of male and female SJS to determine the most effective timing for application of the materials. First, second, and third instars of male and female SJS will be tested for their susceptibility to oils and the IGRs, Esteem® and Applaud®; b) There will also be preparation of living samples of SJS for a workshop and for a life stages brochure (Objective 5). All information collected on the nature, mechanism, and level of resistance present in SJS will enable researchers to develop a comprehensive resistance management plan to be used in an overall pest management strategy for stone fruit pests in California orchards. Dr. Beth Grafton-Cardwell, UC Riverside Entomologist stationed at the Kearney Agricultural Center will be in charge of this project. Other participating individuals include: Walt Bentley, UC IPM Entomologist; Dr. Kent Daane, University of California Center for Biological Control Entomologist; and Yuling Ouyang, SRA III, UC Riverside Entomology, Kearney Ag Center.

4. Study and monitor the movement of secondary pests (i.e., katydids and Western spotted cucumber beetle) that have increased in population, in certain environments, due to implementation of reduced risk practices.

The tasks include: a) Sampling methods during the growing season will include leaf damage assessment, sweep net counts, and beating tray counts for katydids. Katydid eggs will be collected from "cages" and maintained for evaluation of over-wintering emergence and survival in the spring. Eggs will also be tested for potential egg parasitism; b) Western spotted cucumber

beetle will be surveyed in the field and its movement will be documented; c) Several biological and botanical insecticides will be tested on these secondary pests. The principal investigators for this objective will be Walt Bentley, UC IPM Entomologist and Dr. Kent Daane, University of California Center for Biological Control Entomologist. Assisting with the collection and analysis of data will be Shawn Steffan, UC Kearney Agricultural Center Staff Research Associate.

5. Continue to enhance communication and information dissemination to the stone fruit grower community.

The tasks include: a) Continue to enhance communication and information dissemination to the stone fruit grower community. The communications infrastructure of CTFA and CCPGAB, along with cooperating University of California Cooperative Extension personnel, will continue to enhance the exchange of information regarding project progress between researchers, growers, and PCAs. Both industry organizations will provide clingstone canning and fresh market peach, nectarine and plum growers with quarterly updates of project progress through industry websites and newsletters. In addition, CTFA will coordinate four field days, one each in late March or early April, June, July, August and October in cooperation with the University of California, so researchers may communicate directly with growers and PCAs. CCPGAB will coordinate at least 2 field days at demonstration orchards in Yuba County. b) CTFA and CCPGAB will provide an annual report of research progress published in their respective Annual Research Reports. Research results will be incorporated into appropriate internet sites and University Pest Management guidelines. c) There will also be a special workshop for PCAs in the late winter or early spring conducted by Dr. Beth Grafton-Cardwell, which will focus on life stages of scale and how to identify them. She will also develop a SJS, and associated parasitoids, life stages brochure. d) Development of a CD-ROM Disk with information and guidelines garnered from the project will be accomplished and made available to growers next winter. e) A comprehensive survey regarding various aspects of IPM adoption will be sent to growers in the fall in order to establish rates of adoption. This same survey was sent to growers at the end of the 2000 season and will serve as the baseline for the measurement of adoption of reduced risk practices.

Gary Van Sickle, CTFA Research Director; Heidi Sanders, CCPGAB Research Coordinator; Dr. Beth Grafton-Cardwell, UC Riverside Entomologist; and Walt Bentley, UC IPM Entomologist will be responsible for completion of this portion of the project.

B. Results

1. Demonstrate and compare the efficacy and economics of pest control techniques that *do not* rely on OP, carbamate, or pyrethroid inputs to control stone fruit pests at "grower participant" sites in six counties throughout California.

Prior to the 2002 bloom, Gary Van Sickle, Walt Bentley and/or Shawn Steffan met with the participants to review last year's program and discuss the expectations for the coming season. For 2002 the participants included: Daybreak Farms (Tulare County), Deniz Packing Co. (Madera County), Hundal Farms (Yuba County), Kovacevich & Sons (Kern County), Metzler Family Farms (Fresno County), Rubicon Orchards (Tulare County), Schellenberg Farms (Fresno

County) and Tos Farms (Kings County). This brought the number of growers involved in the project to eight this year and the number of varietal sites was 19. Metzler Family Farms was new this season. The stone fruit acreage involved was approximately 140 acres. [Note: Some sites did not have a conventional block associated with it, thus a comparison could not be made for those orchards.]

The PMA approach is much the same as previous years, with the emphasis on dormant oil-only applications, pheromone mating disruption, and reduced-risk materials for in-season pest control. The goal was to accomplish this with equal or less pest damage and pesticide cost. One grower, Bill Tos of Tos Farms, decided to remove the typical organophosphate application in his dormant spray from his conventionally managed acreage. This effectively removed the side-by-side comparison at his farm, but more importantly, it shows a greater confidence in the reduced-risk approach and a willingness to adopt information from this project.

Highlights of the program and results of the comparisons between the PMA and the conventional (CON) blocks follow. Twelve varieties from 11 commercial orchards were examined for insect damage. Harvest dates ranged from May 10 to September 12. Tables 1 and 2 presents overall insect infestation and harvest dates from the orchards sampled. Primary insect and mite pests, and beneficial arthropods were monitored from dormancy to harvest in all orchards.

In the southern San Joaquin Valley sites there was 1.1% difference between PMA and CON orchards based on fruit damage. The PMA program averaged 10.5% damage and the CON program averaged 9.4% damage. As in the previous two years, the earlier harvested varieties resulted in less damage than the later harvested varieties. Only fruit harvested in September (Artic Snow and Sweet September) resulted in damage from Oriental fruit moth, *Grapholitha molesta* (OFM). The most widespread damage occurred from western flower thrips, *Frankliniella occidentalis*, and fork-tailed bush katydid, *Scudderia furcata*; no damage was recorded from peach twig borer, *Anarsia lineatella* (PTB). In Sacramento Valley, OFM caused the most cullage. Unlike last year, the damage was most severe in the Carson variety harvested on July 22. Overall, pest damage was lower in the Sacramento Valley. The PMA orchards averaged 2.2% damage and the conventional orchards averaged 0.8% damage.

In the southern San Joaquin Valley study, the cost of the PMA program was more than the conventional program. This was the reverse of the previous two years. The costs were quite similar however. In the Sacramento Valley, the cost of the PMA program was considerably greater than the conventional program.

Pest populations in the San Joaquin Valley PMA were controlled with pesticides that are not broadly toxic and termed reduced risk, based on the potential for human hazard. Those in the Sacramento Valley integrated the broadspectrum synthetic pyrethroid, Asana®. Costs for each of the orchards are presented in Tables 5-18. Thrips populations in the PMA nectarine blocks were controlled effectively with spinosad applications. There was no difference in thrips damage between the PMA and the CON orchard comparisons. The CON comparison orchards relied on formetanate (Carzol) for thrips control. Spinosad also kills nymphal katydids when applied by early May and was used to manage this pest. OFM populations were monitored with standard

pheromone traps (Trece®), by shoot strikes and fruit damage caused by larval feeding. Management of OFM was done with pheromone confusion.

San Jose scale, *Quadraspidiotus perniciosus* (SJS), was also monitored with standard SJS pheromone and sticky traps (Trece), and spur and fruit examination. Parasitism of SJS was studied by placing unparasitized scale grown on nectarine saplings within selected orchards to measure the impact of the parasitoid *Encarsia perniciosi* on SJS. Parasitism over the previous two years resulted in an average of 28% parasitized scale in the PMA orchards and 11% in the CON orchards.. Management of SJS was done with dormant oil applications. No significant damage occurred for SJS scale in any of the blocks studied. PTB was also monitored with Trece pheromone traps and long life lures. *Bacillus thuringiensis* (Bt) or spinosad (Success®) sprays were the primary materials used for PTB control. In two selected orchards mating disruption with the use of the Suttera Puffers were the techniques used to control PTB. The puffers were used as an experimental technique because of lack of efficacy data. No costs figures were used for the puffer technology. No damage was recorded from PTB in any of the blocks studied. This was also the case in 2001. Katydid and a new pest, spotted cucumber beetle (*Diabrotica undecimpunctata howardi)* were found to cause economic damage in Tulare County during 2001. Spinosad was used for Katydid control while an OP insecticide was used against the spotted cucumber beetle. No soft pesticide is available for this pest.

In the Sacramento Valley, mating disruption was integrated with selected Asana sprays to manage OFM. This program effectively controlled peach twig borer so no separate sprays were used for PTB. The conventional program in the Sacramento Valley utilized a dormant Asana and oil spray, and Asana applied during the season to manage all pest species. The Sacramento Valley has very low SJS populations, and no problems with western flower thrips or forkedtail bush katydid. In an associated study comparisons were made of Trece and Suttera® OFM lures. These were tested in hopes of developing a more effective monitoring device. The dynamics of moth flight were equal among the lure comparisons.

Methods employed: Monitoring is a key part of the PMA program. Knowing the status of pests and beneficial arthropods both inside and outside the orchard can be an important guide in deciding upon the use and type of insecticide. The time spent monitoring orchards in this project is more than can be expected from a commercial PCA. However, the information gained from this detailed monitoring allows for analysis of data gaps in detecting pest damage. The following monitoring guidelines were in place during the season.

<u>*Dormant Season:*</u> Scaffold-twigs were monitored for live SJS, European red mite, *Panonychus ulmi* (ERM) and Katydid eggs. The sample unit is the proximal 3-inch of shoots arising from the inner portion of the scaffold and these are examined under a microscope. Fifty such shoots were sampled from both the CON and the PMA blocks. Five twigs were taken from each of ten trees per block.

<u>*Early Bloom:*</u> For OFM, SJS and omnivorous leafroller, *Platynota stultana* (OLR) pheromone traps were placed in each block. Two traps per block were used. For assessment of adult western flower thrips (WFT) in flowers beating tray samples were used. A single shoot per tree

(each shoot having 10 flowers) from fifty trees per block were sampled. A "beat" is three abrupt raps of the flowering shoot over the tray.

Late Bloom: Fifty flowers per block were dissected and observed. The insects found were recorded. This was done for WFT immature stages and PTB.

Petal-Fall: Katydid egg/nymph sampling consisted of sweeping the orchard cover crop with a sweep net and looking for nymphs. For PTB and codling moth pheromone traps were placed in the orchard. Two traps for each species were placed per block. To monitor for OFM infestation shoots were sampled by examining 50 trees per block. Sweep net samples of 50 sweeps per block were taken for lygus bugs and stinkbugs.

Spring and summer: Pheromone traps were examined once per week. Caps and bottoms were changed at recommended intervals. For obliquebanded leafroller, *Choristoneura rosaceana*, (OBLR) in the Sacramento Valley, traps were placed and monitored through the remainder of the season. Two hundred fruit were examined for evidence of thrips, worms, or katydid damage. Sampling for spider mites on leaves consisted of counting leaf samples. Ten leaves from each of five trees were sampled and counted. A threshold for action was thirty percent infested leaves. This season a comparison was made to the simpler to use 5 minute leaf examination method, which is a presence/absence method. It is hoped that a faster, yet accurate, method for determining need to spray can be developed.

For harvest sampling five hundred fruit (minimum) were sampled at harvest. This was done prior to picking by the harvesting crew. Treatment comparisons are too in depth to discuss pest dynamics at each of the sites. However, tables 5 through 18 present the materials, the dates of the treatments and the costs of the crop protection chemicals used. Arthropod counts were tabulated on a weekly basis and also as a seasonal total on a per trap basis for each block monitored. The average arthropod counts were compared between the PMA and the CON orchards and is presented in Tables 3 and 4. Insect damage counts were also taken every other week and at harvest. Costs of each pest management approach (materials but not application) were tabulated and presented.

Results of Harvest Damage: The harvest samples (500 fruits) were collected from each of the orchards prior to picking/damage sorting by the harvesting crew. Sampling was done throughout the orchard. Fruit and twigs were actually sampled from spring to harvest to detect incipient pest problems prior to producing fruit damage.

Table 1 presents the damage due to various pest insects. In the southern San Joaquin Valley there was a 0.9% difference in damage between the two pest management approaches (PMA versus CON). Overall insect damage averaged 10.5% in the PMA orchards and 9.4% in the CON orchards. Specifically, the PMA orchards averaged 0.7% OFM and the CON orchards averaged 0.5% OFM. The greatest amount of damage from OFM occurred in the Summer Red and Summer Grand varieties. The damage was 2.2%. The CON comparison to the Summer Grand was 1.6%. In the Sacramento Valley, worm damage attributed to OFM was low. The overall PMA infestation averaged 1.5% and the CON program averaged .33%. The highest

infestation was found in the Carson variety PMA block (July 22 harvest). For the second year, no damage was found due to PTB.

Leafroller (OLR) damage was minimal in the southern San Joaquin Valley. The damage averaged less than .7% in the PMA orchards and .6% in the CON orchards. The Sacramento Valley had low levels of leafroller damage. The Andross variety, following the conventional approach, had 1.2% damage and the Carson variety under the PMA approach, had 2% leafroller damage. The remaining varieties had less than 0.5% damage in the Sacramento Valley.

San Jose scale continues to be managed well in the orchards studied in 2002. Each of the PMA orchards in the southern San Joaquin Valley received a single dormant oil spray, while the CON comparisons had a combination of oil and organophosphate, or pyrethroid. The exception to this was the Bright Pearl and the Fire Pearl varieties, which had higher than acceptable damage under both management programs. The Fire Pearl nectarine had 14.2% and 5.2% infestation in the PMA and CON blocks respectively. The damage did not show in the grower's gradeout because the number of scale per fruit averaged less than 2. These orchards will be treated with pryroproxifen in 2003. In the Sacramento Valley, both the PMA and CON orchards received a dormant pyrethroid and oil application. No SJS was detected in that area.

Forktailed bush katydid continued to be a problem in the southern San Joaquin Valley. Damage was particularly severe in the Bright Pearl and Fire Pearl nectarines in Tulare County. Damage attributed to katydid in the Bright Pearl variety was 4.8% and 2.2% for the PMA and CON blocks respectively. Damage in the Fire Pearl was 5% and 6% for the PMA and CON blocks respectively. Damage caused by this pest is quite random and somewhat localized; sampling location has a great bearing on the amount of damage found. Spotted cucumber beetle was last recorded as being a problem in fresh market fruit prior to World War II. It was a pest in both the Bright Pearl and Fire Pearl nectarines in Tulare County in 2001, but did not cause damage in 2002. [More information is provided in response for Objective 4.]

Spider mites were treated in five orchards in 2002. Only two orchards were treated in 2001. The orchards treated this year were: the Red Jim nectarines in Kings County, the Zee Lady and Arctic Snow peaches in Tulare County, and the Summer Red and the Summer Fire varieties in Fresno County. Sampling had indicated increased mite abundance when the cooperating growers treated the orchards. Spider mites were not treated in the Sacramento Valley comparisons.

There was a 1.1% difference in total insect damage between the two management practices in the San Joaquin Valley. The PMA approach resulted in an average of 10.5% damage and the CON program averaged 9.4% damage. In 2000 PMA program averaged 5.7% insect damage and the CON program averaged 5.6% damage. In 2001 the PMA orchards averaged 8.5% and the CON orchards averaged 9.4%. Western flower thrips (on nectarines) and katydid caused most of the damage in the San Joaquin Valley. No damage was recorded for PTB in either 2000, 2001 or 2002. Only Bright Pearl and Fire Pearl nectarines had high levels of SJS infestation, but the number of scale per fruit averaged less than 2 and was not scorable at the time of packing. Damage in the Sacramento Valley was quite low in 2002. The PMA program averaged 2.2% damage and the CON program averaged 0.8% damage. Only two species of insect damage were

found at harvest, OFM and OBLR. These results were quite similar to the 2001 harvest infestations. Very little damage was found from plant bugs.

Trapping Results: Oriental fruit moth pheromone trap counts were low in both the PMA and CON programs, which used mating disruption in 2002. Two types of OFM mating disruption were used last year. The primary product used was Isomate M-100® (Pacific Biocontrol). It was applied at 150 ties per acre. This application provides 30 grams active ingredient with each application. The other product was a sprayable formulation provided by 3M and Suterra Corporations. The Kern County Queen Crest variety trapped no moths where the 3M sprayable was used. The 3M sprayable disruptant was also used following the application of Isomate M-100 hangings in the spring in the Tos orchard. This approach uses the more stable Isomate M-100 for the early part of the season and multiple sprays of the 3M product to cover post harvest activity of OFM. The Madera orchards both used the Suterra OFM Sprayable product with three applications. Mating disruption for OFM has become the conventional method of managing OFM in early to mid season varieties. Only one orchard (Kern) did not use mating disruption in the CON comparison block. Both the PMA and the CON orchard in Kern were removed from production after harvest in May. Trap counts for the first 3 months of the season were low. The greatest number of moths trapped was in the Fresno County Summer Red CON comparison. The two orchards that resulted in any detectable OFM infestation were found in the Fresno Summer Red and Elegant Lady fruit and the Madera Summer Grand fruit. Infestation was at 2%, but the Fresno orchard required sprays of Imidan.

The Fresno Summer Fire orchard utilized the Suterra OFM Sprayable with multiple applications. Overall, trap counts in the PMA orchards were slightly higher than in the CON comparisons (0.47 moths per trap per week vs. 0.26 moths per trap per week). OFM trap counts in the SacramentoValley PMA orchards never totaled more than 4 moths. The CON comparisons that did not use mating disruption reached 1,800 moths per season in one orchard. This indicates a high level of OFM pressure. A more reliable method of detecting breakthrough in mating disruption was the use of shoot strikes caused by feeding of larvae. OFM will infest terminal vegetative shoots prior to moving into the fruit. Watching for this is a reliable early warning for a breakthrough in mating disruption. As strike counts approach five per tree a supplemental spray is warranted if using OFM mating disruption. . Shoot strikes in the Sacramento Valley averaged almost 30 per tree by the end of the third generation. The average seasonal shoot strike count in the San Joaquin Valley PMA orchards was five.

PTB was managed primarily with spinosad or *Bacillus thuringiensis* sprays timed during the bloom period. However, four sites tested the puffer technology (Suttera®). The sites tested with this technology included the two Madera orchards and the two Tulare County orchards. Overall, PTB moth catch in all orchards was extremely low. No PTB infested fruit were found in any of the fruit harvested in the San Joaquin Valley. Moth catch was also quite low in the Sacramento Valley. In these orchards, trap catches ranged from 0 to 22 per season. A total of 54 moths were trapped in the CON Sullivan comparison. In the CON Sullivan comparison, an Asana dormant and three pyrethroid sprays were used during the growing season.

The leafrollers monitored included OLR and OBLR (San Joaquin Valley) and OBLR (Sacramento Valley). Treatments with either Bt, spinosad, or Imidan may have regulated damage

from these two pests in the San Joaquin Valley. Alternatively, the levels found in the orchards may not have been high enough to cause economic damage. OBLR numbers were quite low in the Sacramento Valley comparisons. Each of the orchards there had some OBLR feeding with the late harvested Starn variety, under the PMA program, resulting in the greatest damage (1%). The CON comparison using multiple Ambush sprays had 0.6% damage.

Plant bugs were not found in any of the sampling in either the San Joaquin Valley or Sacramento Valley. Sampling of ground cover, in the process of sampling katydids, did not reveal plant bugs present. This technique is a good early warning system to detect both the presence of these insects as well as the stage of development. Fruit samples during the growing season did not reveal feeding.

Codling moth can be a problem in plum orchards, but it is not often monitored. To get an idea of presence, distribution, and phenology, codling moth traps were set up in 2001 and 2002. The effect of pesticide programs does not appear to have had a significant impact on their populations. (Table 19.) In fact, it is possible the few moths that were caught actually came from neighboring orchards or walnut groves. Several of the blocks being monitored were bordered by large walnut acreages, and codling moth is a well-documented pest of walnut. None of the fruit examined during the course of the season, and none during the final harvest counts, showed any sign of codling moth infestation. However, for plum growers near walnut or apple orchards, it is important to monitor and know when to expect the moth emergence.

The forktailed bush katydid was present in seven of the orchard comparisons and in four of the orchards where no comparisons were made (see Table 1.). In 2002, decisions for treatment were based on the presence of either katydid feeding or the insects themselves. Searches were made in the early spring to detect the typical windowing feeding damage at the tree crotch. Since no thresholds have been developed, presence of damage was an indication of the need to apply an insecticide. First nymphs (first and second growth stage without wings) were found during early April. In all cases spinosad was used in the PMA orchards and Imidan or spinosad in the CON orchards. Varieties requiring katydid treatments included Red Jim in Kings County, Artic Snow, Bright Pearl, Fire Pearl and Zee Lady in Tulare County, and Summer Grand in Madera County. No katydid damage was found in Kern County or the Sacramento Valley orchards.

The insect causing the greatest amount of overall damage in nectarines was Western flower thrip. Each of the nectarine blocks (Bright Pearl, Fire Pearl, Red Jim, Summer Reds, Summer Grand, Sun Diamond and Arctic Snow) was treated at petal fall. The treatments were made for both conventional and the PMA managed orchards. In each of these blocks adults were detected during bloom and a decision to treat was made. Although few utilized the unvalidated thresold of 5% of the flowers with thrips, this threshold was reached in each of the nectarine orchards . Of the six sites where a conventional treatment (Carzol) was compared to the PMA treatment (Success), the PMA treatment had less damage at four sites. An average of 3.54 thrips scarring was found in the Success treated orchards and 3.91 in the Carzol treated orchards. No thrips damage was found in the Sacramento Valley orchards.

Treatment Costs: Treatment costs are presented in Tables 5-18. The costs of the programs varied considerably and were dependent upon the crop, the harvest date, and the location.

Application costs were not included in this analysis. For general purposes the costs of running a dilute spray rig through the orchard is estimated to be $20 per acre. The cost of hanging Isomate ties is estimated at $10 per acre. The cost of OFM Sprayable is approximately $18 per acre. These figures can be plugged into the material cost sheets. If a private consultant is used, a cost of $30 per acre is a good estimate. All of the PMA programs utilized a pest management consultant and four of the seven orchards in the CON program utilized a pest management consultant or farm hired entomologist. The remaining three cooperators utilized agrochemical pest management personnel, whose salary was not directly paid by the farmer.

For the San Joaquin Valley, the average per acre material cost for the PMA program was $198. The average per acre material cost of the CON program was $182 per acre. The three-year average is $189 for both management practices. The lowest cost PMA program was in the Queencrest peach orchard, which cost the farmer $77 per acre. The highest cost PMA program was in the Summer Red nectarines, which cost the farmer $251 per acre. The lowest cost CON program was in the Queen Crest peaches (harvested in May) and cost the farmer $37 per acre. The highest cost CON program was in the Summer Red, which had $276 in material cost.

The cost comparisons were not as favorable in the Sacramento Valley comparisons. However, the cling peach growers do not rely on organophosphate or carbamate insecticides in the CON comparison orchards. Because of the lack of spider mite problems in these locations, farmers have used up to four pyrethroid sprays to manage all of their pest problems. This would not be possible in the San Joaquin Valley, where Pacific mite, *Tetranychus pacificus*, control would be required. Technically, this CON comparison is meeting one of the goals of this project, to lessen the reliance on organophosphate and carbamate insecticides. The approach would not be considered a soft approach, but is the most economical. The PMA comparisons made in the Sacramento Valley resulted in an average material cost of $164 per acre. The CON pyrethroid approach resulted in material costs of $92 per acre (see Tables 15 through 18). The $72 difference is a major impediment to utilizing mating disruption in this area. Interestingly, the CON program in the San Joaquin Valley averages $182 per acre, also more than double the cost of the CON program in the Sacramento Valley. This is, of course, due to the need of fruit destined for the fresh market to be cosmetically beautiful.

Financial Summary for Task 1: The total cost for achieving the objectives of *Task 1* was budgeted at $100,000. To date, $178,673 has been spent towards completing *Task 1.*

2. Continue to assess the SJS population dynamics and evaluate the potential of natural and augmented biological control.

Parasitoid biology. In winter 2001, methods to mass rear SJS parasitoids (*Encarsia perniciosi*, *Aphytis aonidiae*, and/or *Aphytis vandenboschi*) for augmentative release were evaluated. Concurrently, both SJS and parasitoid biology were investigated. Because a great deal of information has already been collected on *A. aonidiae* (by other researchers), efforts were concentrated on *Encarsia perniciosi* and *A. vandenboschi.* In most studies, SJS was reared on butternut squash to produce squash with the desired SJS population (e.g., SJS age, density). The infested squash were provided to parasitoids for studies of host preference, parasitoid

competition and temperature development. Result highlights include the following. (1) *A. vandenboschi* prefers non-gravid adult female SJS (third instar), followed by gravid female SJS and then second instars; first instars were not attacked. (2) *A. vandenboschi* temperature tolerance appears narrower than expected. At constant temperatures, *A. vandenboschi* took 24, 22.2 and 17.5 days to develop (egg to adult) at 20, 25 and 30°C, respectively. It did not develop fully at either 15 or 35°C. (3) In experiments where scale are exposed to both *A. vandenboschi* and *E. perniciosi* (which attacks the earlier SJS stages), *A. vandenboschi* always out-competes *E. perniciosi.* Each of these results has a potential impact on parasitoid performance in the field.

Field cage experiments. In 1999, the potential of a commercially available parasitoid (*Aphytis melinus*) to attack SJS in the field was tested and found this parasitoid species would host feed upon SJS, but did not parasitize SJS in the field. In 2000 and 2002, the effectiveness of mass-released of *E. perniciosi* and *A. vandenboschi* was tested and showed that while *E. perniciosus* parasitized more SJS, *A. vandenboschi* caused greater SJS mortality through a combination of parasitism and host feeding. In 2002, field cage trials focused on (1) the potential competition between *E. perniciosi* and *A. vandenboschi* and (2) the effectiveness of A. vandenboschi at different times of the season. Results show that, as in insectary trials, *A. vandenboschi* out-competes *E. perniciosi.* This data continues to be intriguing as *E. perniciosi* is often more abundant in the field and points to influences of the orchard management practices or SJS field biology (e.g., distribution, size) that create a more favorable condition for *E. perniciosi.* Results from the seasonal influence on *A. vandenboschi* effectiveness are still inconclusive. A working hypothesis is that warmer temperatures in (June-August) and the availability of small scale combine for reduced numbers of *A. vandenboschi* (and poor biological control). Cage trials have not yet provided the needed evidence to support this claim, which is backed by laboratory results.

Orchard/Field Surveys. Results show three parasitoid species dominate the natural enemy complex: *Encarsia perniciosus*, *Aphytis aonidiae*, and *Aphytis vandenboschi.* Highlights of this work are: (1) *E. pernicious* was found in every orchard sampled, (2) *Aphytis* species were less common, (2) *Aphytis* species were less common on SJS pheromone traps, as compared with *Encarsia*, than the recovery of parasitoids from "live" SJS traps (this result indicates that *Aphytis* species densities are not well-represented by collections on SJS pheromone traps), (3) in most orchards, SJS was not an economic problem, in large part due to the action of natural enemies.

Results of orchard surveys clearly indicate that sampling methods for parasitoids (and SJS) need improvement. To determine where on the tree the SJS are most common and to compare SJS distribution to parasitoid species composition and abundance, whole scaffolding branches were removed from a stone fruit orchard that was moderately infested with SJS. Results show that most "visible" SJS located on old scaffolding wood are dead, while the live population resides on new scaffolding wood, and first and second year growth. SJS was especially prominent on sucker growth. This distribution becomes important because the three parasitoid species were not evenly distributed. *Encarsia* was more common on the older scaffolding wood, deeper inside the tree, while *Aphytis* spp. were more common on the outer or smaller branches. The difference in parasitoid distribution in this unsprayed orchard may explain between orchard differences in parasitoid species composition: *Encarsia* was present in all orchards sampled, including those receiving insecticides, while *Aphytis* were more common in fields with summer insecticide

treatments. It is hypothesized that the more hidden location of *Encarsia* may provide some protection from insecticide applications as compared to the more exposed location of *Aphytis*.

One goal of the field surveys was to determine the importance of individual parasitoid species in the regulation of SJS. Because there has been a great deal of success with the augmentation of parasitoids against "diaspid scale" (e.g., releases of *Aphytis melinus* for control of red scale on citrus trees), in 1999, there was work towards the development of an augmentation program for SJS. One of the biggest hurdles for an augmentation program is the development of insectary procedures to mass-rear viable and effective natural enemies. In 2000, laboratory colonies of *A. vandenboschi* and *E. perniciosus* were successfully established. However, numbers of parasitoids produced remained disappointingly low. In September 2000, the first field release trials of *A. vandenboschi* and *E. perniciosus* were conducted. Augmentation studies were conducted this past season in small cages and in open field release trials. Results show an increase in percentage parasitism during a 4-week period (1-generation). Parasitism rates varied between trials, with *Encarsia* parasitizing more SJS but *Aphytis* "killing" more SJS through a combination of host feeding and parasitism. Comparing augmentation results to field densities of parasitism suggests that early-season augmentative release of *Encarsia* would not appreciably add to already present field levels. However, two artifacts of this work are important. First, there is significant crawler mortality simply because the small, delicate insects cannot find suitable feeding sites. This indicates that, as many growers have suspected, tree age, cultivar, and orchard vigor may play a role in SJS densities. Second, mortality of the larger, settled SJS was higher on the uncaged plots than the caged plots. Visual observation revealed that green lacewing larvae were very adept at feeding on SJS and accounted for considerable mortality of the settled scale. [Tests were conducted with "soft" insecticides (Success®, Dimilin®, and Confirm®) on beneficial insects to determine if these materials could negatively impact SJS biological control. Results showed Success had a negative impact on parasitoid adults, while Dimilin had a negative impact on green lacewing larvae.]

Financial Summary for Task 2: The total cost for achieving the objectives of *Task 2* was budgeted at $9,000. To date, $22,030 has been spent towards completing *Task 2.*

3. Examine the effects of reduced risk materials; i.e., oils and the Insect Growth Regulators (IGRs) Esteem® and Applaud,® on various life stages of male and female SJS to determine the most effective timing for application of the materials.

This objective was not completed, except the SJS workshop was held. [The CTFA Research Subcommittee withdrew funding for Dr. Grafton-Cardwell's project for this season.] The workshop is discussed in Objective 5.

Financial Summary for Task 3: The total cost for achieving the objectives of *Task 3* was budgeted at $52,800. To date, *Task 3* has not been completed and no expenditures have been made.

4. Study and monitor the movement of secondary pests (i.e., katydids and Western spotted cucumber beetle) that have increased in population, in certain environments, due to implementation of reduced risk practices.

Feeding by forktailed bush katydid (*Scudderia furcata* Brenner) and western spotted cucumber beetle (*Diabrotica undecipunctata howardi* Barber) are causing economic losses to peach and nectarine farmers. Feeding damage by these two pests has not been seen for decades. There is little information concerning the biology of either pest in stone fruit. This study was designed to identify key biological information on both pests so as to better manage them in a program not relying on organophosphate or pyrethroid insecticides.

The most noteworthy aspect of this season was the high katydid populations observed in the orchards. Most individuals seen in the field have been the forktailed bush katydid, though one block had mostly angular-winged katydids (*Microcentrum retinerve).* Damage due to katydids was mild, overall, but some blocks had pre-thinning damage counts around 10-15%. Spinosad (Success®) was applied at most of the PMA blocks by mid-April, and the conventional blocks had either carbaryl (Sevin®) or phosmet (Imidan®) applied. All katydid populations were effectively suppressed. Thus, monitoring and treatments were initiated in fields with substantial populations. Growers, where possible, waited to time the katydid application with the optimal "window" for OFM or PTB. Katydid damage, as evidenced in the fruit quality graphs, was low and essentially equal between the PMA and CON blocks. (Table 1.)

To determine egg-laying sites within orchards, second leaf potted nectarine trees were covered with organdy netting and infested with 5 katydid adults. The adults were held in cages where egg laying occurred until feeding was reducing the amount of leaf area. The adults were removed and plants are now being held for spring emergence of katydid. In January (2003) the plants were cut to separate leaves, small branches, primary scaffolds, and trunk. Each of these plant locations will be examined daily for emergence of Katydid nymphs. This will allow us to determine if egg laying and survival occurs in leaves, which drop to the ground, or in the bark.

Sampling of both katydid nymphs and damage was performed in 2002. Traditional samples with beating trays were compared to sweep samples of ground cover. Ground cover sweeps were significantly more effective in finding nymphal populations. However, leaf damage due to early season feeding was found to be a better method to determine need for control. Based on eggs held outdoors which came from field-collected material, first hatch was observed on March 26.

In late March and early April 2002, katydid populations and feeding activity were assessed in the 12 Pest Management Alliance blocks being monitored. Monitoring consisted of timed (1 minute per tree) visual searches of the entire mid-tree to lower-tree canopy. The number of katydid nymphs and the number of leaves with katydid feeding were recorded. Approximately ten trees per acre were examined. Samples sizes ranged from 25 to 80 trees per block. Damage was assessed by looking for "windowing" that is caused by feeding of the young nymphal stages. The feeding damage is quite unique. When feeding damage is related to populations of active katydid, there is a close relationship. In May, damaged fruit was counted from 50 trees in each block. A correlation analysis was performed relating either the number of katydids to the number

of damaged nectarines or the number of damaged leaves in April to the number of damaged nectarines in May. Thus, this relationship can be used to predict the need for treatments to control the pest prior to damaging fruit.

An attempt was made to determine minimum temperature threshold for egg hatch in the spring. The objective was to establish the basal development threshold. Three growth chambers were utilized to rear wintered eggs to the adult stage. The base threshold for emergence from eggs is 53.6°F. Acquisition of additional growth chambers this summer will allow for continued development work on the remaining stages. It is hoped to establish treatment timing based on the results of this work.

A study conducted this spring compared how well azadirachtin (AZA-Direct®), spinosad (Success®), and phosmet (Imidan 70-W®) could reduce nymphal katydid population numbers. Azadirachtin and spinosad are considered to be reduced-risk materials because they are relatively short-lived and less toxic to non-target organisms. AZA-Direct, Success, and Imidan were chosen because they are registered products in California nectarines. Various growers, PCAs, and farm advisors have indicated these materials are often effective on katydids, but rates per-acre and precise efficacy information has not been available. Although Imidan is an OP, it was included to provide a benchmark for comparison with the other insecticides.

Results indicated the reduced-risk material, Success, suppressed katydid populations almost as well as the Imidan, though it required an extra day to do so. Respective mortality percentages of 100 and 80% were obtained by the end of the first day. AZA-Direct showed promise (46-50% mortality rate) but did not perform as well as Success. The name based product, AZA-Direct required 7 days for maximum kill. It did not provide acceptable residual kill on katydids. After a week, the AZA-Direct application still was not statistically different from the control, which suggests that the material functions mostly as a contact-kill agent. In terms of acceptable efficacy for growers, the reduced-risk materials do appear to be viable alternatives. AZA-Direct is thought to function as an Insect Growth Regulator (IGR), an anti-feedant, and as a sterilant for females. These field trials were conducted this spring when katydids were 3rd and 4th instars. As they grow, it appears they become more resilient and may not be as effectively suppressed with a given material. For this reason treatments for katydids in the spring are critical. (Table 20.)

Development Studies: Additional information regarding katydids has just come forward from this project. Young forktail bush katydid nymphs were found in a cage study in mid-August and are known to have hatched from eggs laid in June. Until now, it was not known if katydids were limited to one generation per season, or more. It was known there are two hatches per season, one in June and one in August. Until now there was speculation that the hatch in August was entirely from eggs laid the previous year.

Eggs enclosed under a constant temperature of 54° F failed to hatch through July. Those eggs were dissected and determined to still be viable. Eggs held at 59° F hatched between 84 days to 89 days after incubation. The average development time of the eggs was 87.75 days. Eggs held at 72° F hatched after an average of 63.33 days. Egg hatch ranged from 60 to 65 days. Eggs held at 84° F hatched after an average 57 days. The range of egg hatch was 56 to 59 days. A

regression analysis using temperature as the independent variable and days to egg hatch as the dependent variable predicts the minimum temperature for development to be 55° F. This information will now be used to develop a degree-day model for insect development.

Development to the adult stage at each temperature was also recorded. Forktailed bush katydid did not reach maturity when held at 59° F. Development to 2nd and 3rd instar required an average of 50 days and ranged from 43 to 59 days. These individuals died prior to developing wings. The individuals held at 72° F did develop to adults (all males). Development to adults averaged 61 days and ranged from 59 to 64 days. The individuals held at 84° F required an average of 40 days to reach adults (all males). All individuals reached the adult stage at 40 days.

Observations were also recorded from eggs held at ambient outdoor temperature. Three field collected eggs were held outdoors at ambient temperatures. Egg hatch of the field material occurred on March 31, April 6, and April 12. The adult stage was reached on June 8, June 17, and June 18, respectively. Development in the field, based on this small sample size, ranged from 67 to 74 days. These adults were held on either peach plants or nemaguard rootstock plants. A total of 30 eggs were deposited in peach leaves and 12 eggs in nemaguard leaves. These were found on July 7. These eggs were then held for observation for the remainder of the year.

On August 12, 12 katydid first stage nymphs hatched from eggs laid in June and July of the same year. The remaining eggs collected in July were unhatched. The next egg hatch from the July laid eggs was found on September 17. No other hatch occurred for the remainder of the season. Of the fifty eggs held for emergence, that were laid in the late June and July, 13 hatched in August and September. This is the first documentation of two generations of katydid. One of the August 12 hatched eggs reached the adult stage on September 17. Development required 35 days. The remainder of the nymphs reached the adult stage by the end of September.

This information would indicate that good control efforts in the early season on katydid should serve to reduce the population that hatches in August and September.

Various crops and weeds were sampled during the spring and summer that cucumber beetles move from. Over 50 weed and crop species were sampled during the spring and summer. The only crop where beetles were found was alfalfa. The greatest number of beetles collected from a field was ten. Sampling resulted in no finds in corn, even though this is a known host. As planting locations are changed, the presence of the beetle may be affected. Because only 10 beetles were found on one sampling date no trials could be performed. [Sampling will be continued on these crops next season in the hopes of identifying key hosts.]

Orchards with a history of severe feeding were sampled weekly for movement of western spotted cucumber beetle. None were found in the four orchards sampled. The food attractant curbitacin (Kairomone) was evaluated in test orchards as to attraction of adult beetles. The attractant is known to work in the east, but is not widely used in California. No beetles were captured utilizing the commercial traps and bait in the test orchards. Traps were also placed at the Kearney station and no beetles were trapped. It is suspected the quality of the bait was poor, and Trece who sells it commercially has been contacted. A reply from them has not been

forthcoming yet. Because no beetles were captured or found in orchards, chemical tests were not done.

Financial Summary for Task 4: The total cost for achieving the objectives of *Task 4* was budgeted at $15,000. To date, $20,643 has been spent towards completion of *Task 4*.

5. Continue to enhance communication and information dissemination to the stone fruit grower community.

To date, eight PMA field days sponsored and publicized by California Tree Fruit Agreement, California Canning Peach Association and the University of California have been conducted. The events were held to inform growers, pest control advisors, pest control operators, the stone fruit industry and the public about progress made on the PMA project. On March 13, 2002, a winter PMA day was conducted at Kearney Ag. Center in Parlier. This meeting provided an update on using the day-degree model, information on the secondary pest, katydids, and a current pest situation update. There were 51 attendees at the meeting. In order to attract attendees the meeting started at 8 a.m., was kept to one hour, provided one hour of PCA credit and offered a light breakfast to those attending. There was a post-meeting evaluation provided to attendees. Of the 18 who responded, 16 were growers or PCAs. Of that group, 13, representing 18,725 acres, indicated they were using reduced risk practices and one, representing 65 acres, indicated he had not yet adopted any reduced risk practices. There were two who did not respond as to their reduced risk practices.

On April 3, an update meeting was held at the Kovacevich demonstration block located in Kern County. There were approximately eight growers who attended. Mating disruption and the current pest situation were discussed.

The third PMA update meeting was held on April 18 in Hanford (Kings County) at the Tos Farms' demonstration block. Approximately 45 growers and PCAs attended. (Agendas attached.) Sprayables for mating disruption, katydid sampling and parasitoid control of SJS were discussed.

A cling peach PMA update meeting was held on May 31 at the demonstration block located in Yuba County. Approximately 20 growers attended the meeting. Janine Hasey, Yuba Co. Farm Advisor, noted that OFM counts have been very high this year. Walt Bentley reviewed mating disruption techniques. Carolyn Pickel, UC IPM Advisor, reviewed monitoring of mites.

On July 11 & 12 Dr. Beth Grafton-Cardwell conducted a workshop for Pest Control Advisors on how to identify the various life stages of San Jose scale and their parasites, how to predict major events in their lifecycles using degree day units and to estimate the severity of the infestation and the level of biological control in the field. This knowledge helps PCA's and growers make better decisions about scale control tactics in stone fruit orchards. Approximately 20 people attended the workshop. (Schedule attached.)

In striving for better attendance at the demonstration days, the mid-season meeting was delayed and held on September 5, 2002. The thought was that maybe more growers would attend if the

meeting were held after most had finished their harvest for the season. The strategy paid off! There were approximately 130 growers, PCAs and other interested individuals at the meeting. The subject matter included mite sampling, katydid control, SJS monitoring & control and an informational update on the Ten-Lined June Beetle. (Agenda for the field day is attached.) A meeting evaluation was given to the participants. Unfortunately only 25 were handed in at the end of the meeting. In response to questions asking if the attendee was a grower or PCA, there were 18 yes responses and three no responses. (Several evaluations did not list an answer to that question.) Of the 18 yes respondents, 17, representing 15,045 acres of stone fruit, indicated they have implemented reduced risk practices in their orchards. There was one no response, representing 70 acres, who indicated he had not yet implemented any reduced risk practices in his orchard. While these results have not been correlated to an overall industry statistic, it does show that the stone fruit industry continues to make good progress in adopting reduced risk practices.

A year end grower outreach meeting for the season was held on November 5. This was a 2 hour meeting and approximately 60 people attended. It was planned to have two short presentations, which were then followed by a panel discussion. The panel was composed of growers and PCAs involved with the PMA project, and included Bill Tos, Keith Heinrichs, Ryan Metzler, Les Nygren, Steve Strong and Rick Schellenberg. Each was asked to give a short commentary on what worked or didn't work in their reduced risk blocks. After the short commentaries, the discussion was opened to questions from the audience. This format was very well received. An evaluation after the meeting was conducted. There were 22 completed and returned. Of that, 19 were growers or PCAs. Of the 19, 14 indicated they had adopted reduced risk practices. They represented 21,350 acres of fruit. There were three who indicated they had not adopted any reduced risk practices. They represented 410 acres. There were two who did not respond, nor indicate adoption of reduced risk practices. Once again, without trying to subject these numbers to a strict statistical analysis, there appears to be a large segment of growers who have adopted reduced risk practices, certainly those involved with the majority of the stone fruit acreage.

On November 18, Yuba County Farm Advisor Janine Hasey presented the results of the PMA project to PCAs, growers and pheromone company representatives in attendance at an OFM Control Strategies meeting. A roundtable discussion ensued as to the experiences of PCAs and growers during the 2002 season.

On February 14, 2003 a breakfast PMA meeting was held at Kearney Ag. Center in Parlier. Approx. 65 PCAs and growers attended the meeting. Carol Hafner, Fresno County Ag. Department discussed trap placing and trapping aspects for PCAs involved in export protocols for Mexico. Walt Bentley discussed OFM Management and Shawn Steffan previewed the CD Rom disk, which was produced after the season and outlines the basics of the PMA approach, describes the stone fruit pests and presents the results of the three year field program. The disk has been released to several PCAs for review and comment, and a finalized copy to be released later this spring. (A copy of the disk is attached to this report.)

On December 4, 2002, UC researcher Walt Bentley made a presentation at the annual UC Winter Tree Fruit Research Meeting held in Dinuba, CA. He reviewed what had been learned from the project during the previous three seasons, especially for OFM, SJS and katydid management.

On January 10, 2003, UC researcher Walt Bentley was invited to present information from this project to growers at the Southeast Peach Convention, held in Savannah, Georgia. Bentley adapted his presentation to focus on points that were of interest to growers in the southeast. In his presentation he focused on the control of SJS and the use of a dormant treatment of oil only for control. A week later on January 16, 2003, in Portland, Oregon, Bentley made another presentation to the Western Orchard Pest and Disease Management Conference. In his talk he focused on IPM techniques for control of stone fruit pests, based on the results obtained from this project.

On January 29, 2003, Yuba County Farm Advisor Janine Hasey presented the PMA results and OFM control strategies at the 9th annual Sacramento Valley Cling Peach Day. There were approx. 70 PCAs and growers present. Dr. Frank Zalom was also on the agenda and presented "Managing Insecticide Resistance" and Dr. Jim Adaskaveg presented "Managing Disease Resistance".

CTFA's April issue of the research newsletter, *A Closer Look*, summarized key points and progress through the third year of the project. CTFA's research newsletter's July issue (renamed Research Report) reviewed the latest research findings for katydid management. The October issue had an article providing an update on the PMA project with results from the 2002 season. The January 2003 issue contained an article listing practices for protecting surface water (from pesticide run off). CCPA's and CTFA's newsletters are mailed to over 3,000 growers, PCAs, PCOs, shippers, packers and other parties associated with the clingstone canning and fresh market stone fruit industries.

Information from the project has also been made available to the public via CTFA's and KAC's web site. The KAC website has specific pages devoted to stone fruit pest management and this past season was updated on a weekly basis with the day-degree information for most of the major pests in the San Joaquin Valley.

CTFA's annual research report, which included the individual progress reports from the UC researchers associated with the PMA project, was published and made available to growers / PCAs in the late spring 2002).

In the May 2002 issue of the *The Grower* magazine there was an article by editor Vicky Boyd, which reviewed this reduced risk project. *The Grower* claims they reach commercial producers who control 90% of the fruit and vegetable acreage. The article highlighted the demonstration efforts and the goal of showing stone fruit growers that non-disruptive techniques can be as effective as conventional practices and for the same comparable price. (Copy attached.) The October issue of *California Farmer* had an article based on the May PMA field day held at Yuba City. It reported on the presentations given at the field day.

The California Agricultural Technology Institute (California State University, Fresno) had an article on the project in its Summer 2002 Update. It touted the research efforts focusing on materials that could replace conventional organophosphates and provide information to growers

regarding alternative, reduced risk practices and control methods. Most recently the February 2003 issue of *Western Fruit Grower* magazine published an article by UC Research Associate Shawn Steffan. In the article Steffan reviewed the problems that katydids are now causing in the stone fruit crops and reviewed IPM control measures for them.

On October 21, 2002 a comprehensive survey was sent to 1,923 growers. The purpose of the survey was to get information from growers regarding their adoption of IPM practices. The survey was 14 pages in length and was very detailed as to different types of IPM practices that might have been adopted. This same survey was previously sent to growers at the end of the 2000 season, which will serve as the baseline for comparing the results of the two surveys. As of November 8, 2002 there were responses from 104 growers. A second mailing was sent on November 20, 2002. There were 1,756 surveys mailed to growers who had not previously responded to the first mailing. There were 111 responses to that mailing, thus providing 215 responses. Full copies of each of the two surveys (same questions, just the dates used were updated) with the responses tabulated for each question are attached to this report. The responses will not be subject to a statistical evaluation at this time, but some general observations based on the responses will be made. Overall, the responses show a slight shift towards the adoption of more IPM practices, compared to the baseline survey. For question 14 A (Q14 A), in 2000 there were 82% who indicated that a dormant insecticide was used; in 2002 the response to the same question was 81%. A similar type question, question 14 J (Q14 J) asked if a dormant oil without insecticide was used to kill scale or mite eggs. In 2000 the response was 29%; in 2002 the response jumped up to 34%. Somewhat disappointing, based on the extensive outreach efforts the past several years, were the answers to question 19 (Q 19). In 2000, 3% stated they were not at all knowledgeable about IPM, 36% said they were somewhat knowledgeable, 39% said they were moderately knowledgeable and 22% said they were very knowledgeable. In 2002, 7% stated they were not at all knowledgeable about IPM, 36% said they were somewhat knowledgeable, 37% said they were moderately knowledgeable and only 20% said they were very knowledgeable. Let's hope the extensive outreach efforts have helped many to realize they may not be as knowledgeable about IPM as they thought they were.

Financial Summary for Task 5: The total cost for achieving the objectives of *Task 5* was budgeted at $58,441. To date, approximately $52,713.64 has been spent towards meeting the objectives of *Task 5.*

C. Discussion

The results of the 2002 program were quite similar to the 2001 and 2000 programs. Overall insect damage in the San Joaquin Valley in 2000 was 5.6% in the CON approach (utilizing organophosphates) and 5.7% damage in the PMA program. In the San Joaquin Valley in 2001, the CON program averaged 7.5% and the PMA program averaged 7.8% damage. In 2002 the CON program averaged 9.4% damage and the PMA averaged 10.5%. During all three years, in the San Joaquin Valley, OFM damage was minimal until the late season fruit harvest and PTB was not a problem. San Jose scale problems were also minimal. It appears that the PMA program does not contribute to outbreaks of the pests considered the primary target of organophosphate and carbamate materials. The two insects causing the greatest damage in the

San Joaquin Valley were Western flower thrip and katydid. There was no difference in damage by these two pests between the two approaches to controlling them.

In the Sacramento Valley in 2002 insect damage in the PMA orchards averaged 2.2%, while the CON orchards averaged 0.8%. In 2000, damage averaged 6% in the PMA program and 4.7% in the CON program. In 2001, damage in the PMA program averaged 2.9% and the CON program (relying on pyrethroids) averaged 0.7%.

Overall, in the San Joaquin Valley for 2002, dollars expended on pest management materials were less in the CON program than the PMA program, but the difference was minor. Over the three-year period, costs are equal. A major concern being brought by many farmers is the loss of organophophates and carbamates because of the results of this project. There are reasons these materials should be kept. One is the occurrence of migrating plant bugs such as spotted cucumber beetle, stinkbug, boxelder bug, and lygus bug. None of the soft materials provide control of these pests. Although the pyrethroid class insecticides do control them, Pacific spider mite problems, as a result of their use, make them an unwise choice in the San Joaquin Valley. Miticides range in cost from $25 to $70 per acre. The cost of the PMA in the Sacramento Valley was approximately two times that of the conventional pyrethroid approach.

A continuing problem in mating disruption orchards has been the breakdown of the OFM pheromone confusion products in August. In the current program, two applications of Isomate M or Suterra Check Mate would help reduce this late season damage. A cost effective method of application is necessary to reapply products (preferably in late July) that would extend the mating disruption into September. The development of the sprayable confusion products by Suttera and 3M will make this possible. Also, the longer lasting M-Rosa product formulated by Pacific Biocontrol will accomplish the desired goal. [These products will be included in the 2003 program.] The use of "strike" counting appears to be a good technique to warn of disruption failure. In the late harvested peach varieties, increases in the number of strikes per tree gave a clear picture of the need for additional OFM control. Through an alternative funding source, the program will be integrating an OFM parasitoid, *Macrocentrus ancylivorus,* into the program in 2003.

The challenges that remain include better sampling techniques, and better control methods for forktailed bush katydid and spotted cucumber beetle. A sampling plan for katydids that relies on identifying damaged leaves, in the lower central portion of the tree canopy, gave good prediction of damage to fruit. The presence of katydids was not as accurate. During the month April, a visual count of leaves in the crotch of trees should be done. A minimum of 50 trees per 20-acre block should be examined. If 1 out of 3 trees show feeding, a treatment would be required. Finally, a minimum of 55° F is required for egg hatch to occur. At a constant temperature of 55° F nymphs were not able to reach the adult stage. This threshold may require refinement to 60° F. In the field, two months after egg eclosian are required for development to adults. This information is important. If adults are able to develop, they are able to fly long distances and move in and out of orchards. Chemical control is extremely difficult on migrating adult katydid. For the first time, a second generation of katydids was documented. Many farmers and PCAs have suspected this but only one generation had been previously identified. The second generation reaches the adult stage in September and is able to lay eggs at that time. Not all eggs

laid in June and July develop into the second generation. Approximately 75% of the eggs laid during those months did not hatch, but are expected to hatch in the spring of 2003. Also, a nondisruptive method of managing stinkbugs and lygus bugs is needed.

A key issue of concern from the California Environmental Protection Agency is the management of organophosphate runoff. This is less of a problem in the Southern San Joaquin Valley, but still is an issue that must be dealt with. In this demonstration project, it was possible to manage San Jose scale and European red mite with dormant oil sprays alone. Although this does not control peach twig borer, the use of either Bt sprays or Success sprays during bloom, or at the proper development timing in the late spring, has kept this pest under control. The timing for PTB appears to have worked for the OLR and OBLR as well. More important to the grower, the cost of this approach in the San Joaquin Valley has been equal to the conventional program. Because farmers in the Sacramento Valley rely on pyrethroid sprays for both PTB and OFM control, their approach is less costly than the integration of OFM mating disruption. Multiple pyrethroid sprays work well currently, but this approach will not be sustainable. As was the case with the organophosphates, resistance will develop to the use of these broad-spectrum sprays. Growers cannot be faulted for using the sprays while they are currently working. A cost savings of $75 to $100 per acre in the Sacramento Valley is too much for them to sacrifice. The integration of less costly and more easily applied mating disruption products appears to be feasible.

Thus, technical challenges, including increasing evidence SJS is resistant to OPs, growers experiencing unacceptable fruit damage while using pheromone mating disruption for PTB and OFM, and grower concerns of economic loss during the transition of instituting reduced risk practices, have been barriers to developing a comprehensive integrated pest management program for clingstone canning and fresh shipping peaches, plums and nectarines. The testing of commercially available oils, pheromone dispenser systems and reduced risk pesticides in a controlled research environment has provided a representation of best management practices for utilizing a more intense integrated pest management approach. Furthermore, development of a biological control program with augmentation of natural enemies may increase SJS, PTB and OFM parasitism levels and further reduce the need for OP/carbamate applications.

Overall, advancement in the objectives, as the fourth year of this project is concluded, has been made. An analysis of the data indicates SJS, PTB and OFM populations should be maintained below an economic injury level in stone fruit without, or with minimal use of, OPs and carbamates. Thus, eight grower demonstration plots (19 blocks) were established during the winter/spring of 2001-02, which have incorporated the reduced risk practices outlined in this project. The implementation of these demonstration blocks addressed the dynamic pest management pressures in a commercial setting, from dormant sprays to beyond harvest. The successful performance of the combination of replacing OPs with oil, pheromone mating disruption and augmenting with natural enemies, under conditions and acreages growers typically contend with, should increase grower confidence in the efficacy of alternative materials and reduced risk practices.

D. Summary and Conclusions

This is the fourth year of a comprehensive pest management project where a systems approach (intensive field monitoring, use of mating disruption, use of biological agents and implementation of reduced risk materials) has been taken to examine reduced risk alternatives for controlling SJS, PTB and OFM in clingstone and fresh market peaches, plums and nectarines. The objectives of this multi-year project distinctly seek to substantially reduce reliance on OPs and/or carbamates and provide a model sustainable pest management system for stone fruit growers throughout the state of California.

Previously, the project compared the efficacy of commercially available horticultural oil as the single component in a dormant spray for controlling SJS, compared to a traditional OP application, and found moderate populations of scale could be reduced under dilute application conditions.

Work has also progressed in developing a biologically and economically viable inundating release program for natural enemies of SJS. Commercial orchards have been surveyed and endemic natural enemies of SJS have been identified. As a result, laboratory colonies of two potential groups of parasitoids, *Aphytis vandenboschi* and *Encarsia perniciosi*, have been established for future use as potential augmentative biological control agents against SJS. Previous sampling of sentinel scale host plants has revealed that the activities of these two parasitoids can remove a significant number of the scale population from the orchard. Work is also continuing to determine the effect of secondary pests, especially katydids, on the crop and how best to control those pests.

The CTFA and CCPA continue to utilize their communications infrastructures to: sponsor and publicize UC grower education days, publish newsletters and maintain active websites highlighting progress made on the PMA project. Through this continued effort, hundreds of growers and professional crop care consultants are being exposed to alternative, reduced-risk practices that effectively address the pest complexes of the stone fruit industry.

Thus, successful demonstration of utilizing horticultural oils in dilute dormant applications in combination with pheromone mating disruption, use of new reduced-risk materials and the development of an augmentative parasitoid program in a commercial setting, should increase grower confidence in the efficacy of alternative materials and reduced risk practices. A grower survey first conducted in 2000 and then conducted again in 2002, indicates some conflicting trends, yet there are comparisons and conclusions that can be made that indicate a gradual shift by the industry to adopt more IPM practices. This is further evidenced with PUR data discussed below.

Finally, evidence of reduced usage of OPs continues to emerge. As previously reported for this project, evaluations of participants attending field days projected that approximately two-thirds of the industry, on two-thirds of the acreage, are implementing reduced risk practices. Additional evidence is reported in the Peach Pest Management Strategic Plan, which is currently being

updated by the California Minor Crops Council. In the plan one of the statistics presented is the following: "Since the late 1990's, the California peach industry has reduced its use of organophosphate (OP) insecticides by approximately 50%. Major alternatives to OP use have included the use of pheromones, insect growth regulators and reduced risk pesticides."

The California Department of Pesticide Regulation's PUR data for 2001 was released in mid October 2002. It singles out peaches and nectarines, indicating that total pounds on these two commodities decreased by about 780,000 pounds, and acres treated decreased by 980,000 acres from 2000 to 2001. For the 1993-2001 period, 2001 ranked the second lowest, while 2000 ranked the third highest. Total pounds used during that timeframe were relatively constant. The largest decreases included copper sulfate, methyl bromide and chlorpyrifos. The largest increases included phosmet and propargite. 2001 was a much drier year than 2000, which accounts for the decrease in some of the materials used during the bloom period. Many growers, who are attempting to adopt IPM practices, are using phosmet as an in-season insecticide in place of other, more toxic chemicals, such as methomyl. Above average infestations of mites occurred in 2001, which accounts for increases in propargite. Use of certain high toxicity OPs and carbamate such as methomyl, azinphos-methyl, methidathion, diazinon and chlorpyrifos all showed decreases. Some growers are now adding esfenvalerate to their dormant oil sprays in place of chlorpyrifos. This strategy may also account for the decline in Bt use. Similar results have been shown for plums, although their usage of chlorpyrifos has increased instead of declining. (Table 21.) Clearly, this information is evidence of the success of the project and its outreach efforts.

REFERENCES

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Daane, Kent M. , San Jose Scale Natural Enemies: Investigating Natural or Augmented Controls. California Tree Fruit Agreement, Research Report, 2002.

Appendix

Table 1. Damage due to various insects in Stone Fruit Pest Management Alliance Orchards in the San Joaquin Valley, 2002

	Fruit Damage Counts (units: # damaged/ 100 fruit; N = 500)								
County/Variety	SJS	OFM	OLR	thrips	katydid	Cucumber beetle	NOW	**Total Pest Damagee**	**% Clean**
Kern/Queen Crest									
PMA	0.2	0.4	0	0	0	0	0	0.6	95.4
Standard	0	0	0	0	0	0	0	0	96.6
Fresno/Elegant Lady									
PMA	0.4	0.2	0.2	0	0	0	0	0.8	99.2
Standard	0	1.4	0.2	0	0.2	0	0	1.8	98.2
Fresno/Summer Red									
PMA	0.2	2.2	0	2.8	2	0	0	7.2	92.8
Standard	0	0.6	0	3	1.6	0	0	5.2	94.8
Fresno/Sweet September									
PMA	0	0	0.2	0	0.8	0	0	1	99
Fresno/Summer Fire									
PMA	0	0	0.4	0.8	2.2	0	0	3.4	96.6
Madera/Summer Grand									
PMA	0	2.2	1.4	3.6	2.2	0	0	9.4	90.6
Standard	1	1.6	1.2	7.2	0.8	0	0	11.8	88.2
Madera/Sun Diamond									
PMA	0	0	0.4	12	6	0	0	18.4	81.6
Standard	0	0.2	0.2	8	5.4	0	0	13.8	86.2
Kings/Red Jim									
PMA	0.2	0	0	0.8	0.8	0	0	1.8	98.2
Standard	0	0	0.2	2.2	0.8	0	0	3.2	96.8
Tulare/Bright Pearl									
PMA	5	0	0.2	2.8	4.8	0	0	12.8	87.2
Standard	6.8	0	0.6	2.2	2.2	0	0	11.8	88.2

	Fruit Damage Counts (units: # damaged/ 100 fruit; N = 500)								
County/Variety	SJS	OFM	OLR	thrips	katydid	Cucumber beetle	NOW	**Total Pest Damagee**	**% Clean**
Tulare/Fire Pearl									
PMA	14.2	0	0.8	2.8	5	0	0	22.8	77.2
Standard	5.2	0	2	4.8	6	0	0	18	82
Tulare/Zee Lady									
PMA	0.2	0.2	0	0	0.6	0	0	1	99
Tulare/Arctic Snow									
PMA	0	0	0.2	1	1.8	0	0	3	97
Average totals (comparison-blocks. SF, ZL, AS, and SS excluded)									
PMA	2.85	0.66	0.43	3.54	3	0	0	10.48	89.52
Standard	1.86	0.54	0.63	3.91	2.43	0	0	9.37	90.63

Table 2. Damage due to various insects in Stone Fruit Pest Management Alliance Orchards in the Sacramento Valley, 2002

Sacramento Valley County/Variety	OFM	PTB	OBLR	SJS	Katydid	Diabrot	NOW	Thrips	Total	Harvest Date
Sutter/ Hundal Farms										
PMA (Carson)	3.6	0	2	0	0	0	0	0.0	**5.6**	Mid
Standard (Andross)	0.2	0	1.2	0	0	0	0	0	**1.4**	
Sutter/ Hundal Farms										
PMA (Monaco)	0.2	0	1	0	0	0	0	0	**1.2**	Late
PMA (Halford)	1.2	0	0	0	0	0	0	0	**1.2**	
Standard (Ross)	0.2	0	0.2	0	0	0	0	0	**0.4**	
Sutter/ Hundal Farms										
PMA (Starn)	0.8	0	0	0	0	0	0	0	**0.8**	Extra-late
Standard (Sullivan)	0.6	0	0	0	0	0	0	0	**0.6**	

Average Sacramento Valley comparison blocks County/Variety	OFM	PTB	OLR	SJS	Katydid	Diabrot	NOW	Thrips	Total	
PMA	1.45	0	.75	0	0	0	0	0	**2.2**	
Standard	0.33	0	0.46	0	0	0	0	0	**0.79**	

Table 3. Average Seasonal (Feb-Sept) of arthropods monitored in the San Joaquin Valley, 2002

Management Technique	OFM	PTB	OLR	OBLR	CM	SJS	Encarsi	Aphytis
PMA	15	16	392	43	16	334	783	24
Standard	23	11	354	65	15	344	912	53

Table 4. Average Seasonal (Feb-Sept) of arthropods monitored in the Sacramento Valley, 2002

Management Technique	OFM	PTB	OLR	OBLR	CM	SJS	Encarsi	Aphytis
PMA	2	9	Not trapped	519	Not trapped	779	479	166
Standard	1337	93	Not trapped	582	Not trapped	1145	295	242

Table 5. Insecticide and miticide costs, Queen Crest peaches, Kern County, 2002

Kovacevich Orchards	PMA block				Standard block			
Stage	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**	**Product**	**Date**	**Rate/Acre**	**Cost/Acre**
DORMANT (Nov-Jan)	Hort Oil	1/26	6 gal	$21	Hort Oil Asana	1/29 1/29	8 gal/400 gal 8 oz	$21 $16
Subtotal				**$21**				**$37**
BLOOM (Mar-Apr)	OFM sprayable	3/15		$30				
Subtotal				**$30**				**$37**
IN-SEASON	Bt (Deliver)	4/30	1 lb	$26				
Total				**$77**				**$37**

Table 6. Insecticide and miticide costs, Bright Pearl nectarines, Tulare County, 2002

Strong Orchards: Bright Pearl nectarines								
		PMA block			**CON block**			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/24/02	8 gal	$24	Hort Oil	1/24/02	8 gal	$24
					Supracide	1/24/02	5 pts.	$48
subtotal				**$24**				**$72**
BLOOM	Success	3/10/02	6 oz	$29	Carzol	3/10/02	1 lb.	$25
subtotal				**$53**				**$97**
IN-SEASON	Success	4/8/02	6 oz	$29	Sevin	4/8/02	5 lbs.	$31
	HortOil	4/8/02	1 gal	$3				
	3M OFM Sprayable Pheromone	multiple apps	1.5 oz.	$56	3M OFM Sprayable Pheromone	multiple apps	1.5 oz.	$56
Total				**$141**				**$184**

Table 7. Insecticide and miticide costs, Fire Pearl nectarine, Tulare County, 2002

Strong Orchards: Fire Pearl nectarines								
	PMA block				**CON block**			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/24/02	8 gal	$24	Hort Oil	1/24/02	8 gal	$24
					Supracide	1/24/02	5 pts	$48
subtotal				**$24**				**$72**
BLOOM	Success	3/10/02	6 oz	$29	Carzol	3/10/02	1 lb.	$25
subtotal				**$53**				**$97**
IN-SEASON	Success	4/8/02	6 oz	$29	Sevin	4/8/02	5 lbs.	$31
	HortOil	4/8/02	1 gal	$3				
	3M OFM Sprayable Pheromone	multiple apps	1.5 oz.	$56	3M OFM Sprayable Pheromone	multiple apps	1.5 oz.	$56
Total				**$141**				**$184**

Table 8. Insecticide and miticide costs, Red Jim nectarines, Kings County, 2002

Tos Farms: Red Jim nectarines

	PMA block				Standard block			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/4/02	8 gal	$24	Hort. Oil	1/4/02	8 gal	$24
	Asana XL	1/4/02	4 pints	$16	Asana XL	1/4/02	4 pints	$16
subtotal				**$40**				**$40**
BLOOM	Isomate M100	2/20/02	0.94 oz	$35	Isomate M100	2/20/02	0.94 oz	$35
	Success	3/19/02	1 lb.	$12	DiPel DF	3/19/02	1 lb	$12
					Carzol	3/19/02	1 lb	$25
subtotal				**$87**				**$112**
IN-SEASON	Success	4/16/02	6 oz.	$29	Imidan 70	4/18/02	2 lbs	$13
	Success	4/24/02	6 oz.	$29	Imidan 70	4/24/02	4 lbs	$26
	Isomate M100	6/11/02	9.4 oz.	$35	Isomate M100	6/10/02	9.4 oz.	$35
	Acramite	7/29/02	0.5 lb.	$34	Acramite	7/29/02	0.75 lb.	$51
	Success	7/29/02	6 oz.	$29	Success	7/29/02	6 oz.	$29
Total				**$243**				**$266**

Table 9. Insecticide and miticide costs, Summer Grand nectarines, Madera County, 2002

Deniz Packing: Summer Grand nectarines								
	PMA block				**Standard block**			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/24/02	8 gal	$24	Hort. Oil	1/25/02	6 gal	$18
					Diazinon AG600	1/29/01	0.4 gal	$15
subtotal				**$24**				**$33**
BLOOM	Crymax Bt	3/14/02	1 lb	$13	Crymax Bt	3/14/02	1 lb	$13
	Success	3/24/02	6 oz	$29	Carzol	3/24/02	1.25 lb	$31
subtotal				**$66**				**$77**
IN-SEASON	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56
	Imidan	6/18/02	4 lbs.	$26	Imidan	6/18/02	4 lbs.	$26
Total				**$148**				**$159**

Table 10. Insecticide and miticide costs, Sun Diamond nectarines Madera County, 2002

Deniz Packing: Sun Diamond nectarines								
	PMA block				**Standard block**			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/24/02	8 gal	$24	Hort. Oil	1/25/02	6 gal	$18
					Diazinon AG600	1/29/01	0.4 gal	$15
subtotal				**$24**				**$33**
BLOOM	Crymax Bt	3/14/02	1 lb	$13	Crymax Bt	3/14/02	1 lb	$13
	Success	3/21/02	6 oz	$29	Carzol	3/21/02	1.25 lb	$31
subtotal				**$66**				**$77**
IN-SEASON	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56
Total				**$122**				**$133**

Table 11. Insecticide and miticide costs, Summer Red nectarines Fresno County, 2002

Schellenberg Farms: Summer Red nectarines								
	PMA block				**CON block**			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/14/02	10 gal	$30	Hort. Oil	1/12/02	6 gal	$18
					Lorsban 4E	1/12/02	4 pints	$40
subtotal				**$30**				**$58**
BLOOM	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56
	Success	4/10/02	6 oz.	$29	Success	4/10/02	6 oz.	$29
subtotal				**$115**				**$143**
IN-SEASON	Success	4/10/02	6 oz.	$29	Imidan 70W	4/10/02	4 lbs.	$26
	Apollo	6/1/02	5 oz.	$55	Apollo	6/1/02	5 oz.	$55
	Imidan 70W	6/1/02	4 lbs.	$26	Imidan 70W	6/1/02	4 lbs.	$26
	Imidan 70W	7/8/02	4 lbs.	$26	Imidan 70W	7/8/02	4 lbs.	$26
Total				**$251**				**$276**

Table 12. Insecticide and miticide costs, Elegant Lady peaches, Fresno County 2002

Schellenberg Farms: Elegant Lady peaches								
	PMA block				**CON block**			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/15/02	10 gal	$30	Hort. Oil	1/12/02	6 gal	$18
					Lorsban 4E	1/12/02	4 pints	$40
subtotal				**$30**				**$58**
BLOOM	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56
subtotal				**$86**				**$114**
IN-SEASON	Apollo	6/2/02	5 oz.	$55	Imidan 70W	4/16/02	4 lbs.	$26
	Imidan 70W	6/2/02	4 lbs.	$26				
	Success	7/8/02	6 oz.	$29				
Total				**$196**				**$140**

Table 13. Insecticide and miticide cost, Summer Fire nectarines Fresno County 2002

Metzler Family Farms: Summer Fire nectarines				
	CON orchard			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	2/14/02	7 gal	$21
	Lorsban 4E	2/14/02	4 pints	$40
	Asana XL	2/14/02	8 oz.	$5
subtotal				**$66**
BLOOM	Checkmate OFM Sprayable	Multiple Apps	1.3 oz.	$56
	Success	3/26/02	6 oz.	$29
subtotal				**$151**
IN-SEASON	Omite 30WS	6/27/02	6 lbs.	$30
Total				**$181**

Table 14. Insecticide and miticide costs, Artic Snow and Zee Lady peaches, Tulare County, 2002

Daybreak Farms

Arctic Snow nectarines PMA block					Zee-Lady peaches PMA Block				
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Stage**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
DORMANT	Hort. Oil	1/3/02	6 gal	$18	DORMANT	Hort. Oil	1/3/02	6 gal	$18
subtotal				**$18**					**$18**
BLOOM	Isomate M100	3/1/02	1.14 oz.	$35	BLOOM	Isomate M100	3/1/02	1.14 oz.	$35
	DiPel	3/1/02	1 qt.	$12		DiPel	3/1/02	1 qt.	$12
	Success	3/12/02	6 oz.	$29		DiPel	3/10/02	1 qt.	$12
subtotal				**$94**	**subtotal**				**$77**
IN-SEASON	Success	4/5/02	6 oz.	$29	IN-SEASON	Success	4/5/02	6 oz.	$29
	Success	5/10/02	6 oz.	$29		Success	5/11/02	6 oz.	$29
	Isomate M100	6/6/02	1.14 oz.	$35		Checkmate OFM-F	6/6/02	0.52 oz.	$5
	AZA-Direct	6/7/02	32 oz.	$40		AZA-Direct	6/6/02	32 oz.	$40
	Omite 30W	7/20/02	5 lbs.	$30		Acramite	7/8/02	0.75 lb.	$51
	Checkmate OFM-F	7/27/02	1.3 oz.	$14					
Total				**$271**	**Total**				**$231**

Table 15. Insecticide and miticide costs, Carson and Andross Peaches, Sutter County, 2002

	Carson PMA Block				Andross Standard Block			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
Dormant	Super 94 Oil	1/16/02	4 gal	$9.00	Super 94 Oil	1/16/02	4 gal	$9.00
	Nordox	1/16/02	10 lbs	$20.00	Nordox	1/16/02	10 lbs	$20.00
subtotal				**$29.00**				**$29.00**
Bloom [1]	Dipel 3/2/02,3/17/02,1 qt ,$20.00							
subtotal				**$20.00**				
Pheromone Application	Checkmate OFM	3/5/2002	108	$38.00	OFM Flowable	8/17/02	1.3 oz	$15.00
	OFM Flowable	8/17/02	1.3 oz	$15.00				
	Nufilm	8/17/02	6 oz	$1.00				
subtotal				**$54.00**				**$15.00**
In-Season	Asana	6/28/2002	10 oz	$9.00	Ambush	5/27/02	10 oz	$9.00
					Asana	6/28/02	10 oz	$9.00
					Asana	7/18/02	10 oz	$9.00
subtotal				**$9.00**				**$27.00**
Total				**$112.00**				**$71.00**

Table 16. Insecticide and miticide costs, Halford and Ross peaches, Sutter County, 2002

	Halford PMA Block				Ross Standard Block			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
Dormant	Super 94 Oil	1/16/02	4 gal	$9.00	Super 94 Oil	1/16/02	4 gal	$9.00
	Nordox	1/16/02	10 lbs	$20.00	Nordox	1/16/02	10 lbs	$20.00
subtotal				**$29.00**				**$29.00**
Bloom [1]	Dipel 2/27/02,3/17/02 1 qt $20.00							
subtotal				**$20.00**				
Pheromone Application	OFM Isomate M-100	2/27/02	134	$44.00	OFM Flowable	8/17/02	1.3 oz	$15.00
	OFM Flowable	8/17/02	1.3 oz	$15.00				
	Nufilm	8/17/02	6 oz	$1.00				
subtotal				**$60.00**				**$15.00**
In-Season	Success	5/25/02	6 oz	$32.00	Ambush	5/27/02	10 oz	$9.00
	Asana	7/18/02	10 oz	$9.00	Asana	6/29/02	10 oz	$9.00
					Asana	7/19/02	10 oz	$9.00
subtotal				**$41.00**				**$27.00**
Total				**$150.00**				**$71.00**

Table 17. Insecticide and miticide costs, Monaco and Ross peaches, Sutter County, 2002

	Monaco PMA Block				Ross Standard Block			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
Dormant	Super 94 Oil	1/16/02	4 gal	$9.00	Super 94 Oil	1/16/02	4 gal	$9.00
	Nordox	1/16/02	10 lbs	$20.00	Nordox	1/16/02	10 lbs	$20.00
					Asana	1/16/02	8 oz	$7.00
subtotal				**$29.00**				**$36.00**
Bloom [1, 2]	Dipel 2/27/02,3/17/02 1 qt $20.00							
subtotal				**$20.00**				
Pheromone Application	OFM Flowable	2/27/02	1.3 oz	$15.00	OFM Flowable	8/17/02	1.3 oz	$15.00
	Dual	5/2/02	108	$85.00				
	OFM Flowable	8/17/02	1.3 oz	$15.00				
	Nufilm	8/17/02	6 oz	$1.00				
subtotal				**$116.00**				**$15.00**
In-Season	Asana	6/29/02	10 oz	$9.00	Ambush	5/27/02	10 oz	$9.00
	Asana	7/20/02	10 oz	$9.00	Asana	6/29/02	10 oz	$9.00
					Asana	7/19/02	10 oz	$9.00
subtotal				**$18.00**				**$27.00**
Total				**$183.00**				**$78.00**

Table 18. Insecticide and miticide costs, Starn and Sullivan #4 peaches, Sutter County, 2002

	Starn PMA Block				Sullivan #4 Standard Block			
Stage	**Product**	**Date**	**Rate/acre**	**Cost/acre**	**Product**	**Date**	**Rate/acre**	**Cost/acre**
Dormant	Super 94 Oil	1/16/02	4 gal	$9.00	Super 94 Oil	1/16/02	4 gal	$9.00
	Nordox	1/16/02	10 lbs	$20.00	Nordox	1/16/02	10 lbs	$20.00
					Asana	1/16/02	8 oz	$7.00
subtotal				$29.00				$36.00
Bloom [1]	Dipel 2/27/02,3/17/02 1 qt $20.00							
subtotal				$20.00				
Pheromone Application	Isomate m-100	2/26, 2/27	150	$50.00	OFM Flowable	8/17/02	1.3 oz	$15.00
	OFM Flowable	8/17/02	1.3 oz	$15.00				
	Nufilm	8/17/02	6 oz	$1.00				
subtotal				$66.00				$15.00
In-Season	Ambush	5/28/02	10 oz	$9.00	Ambush	5/28/02	10 oz	$9.00
	Asana	6/30/02	10 oz	$9.00	Asana	6/30/02	10 oz	$9.00
	Asana	7/20/02	10 oz	$9.00	Asana	7/20/02	10 oz	$9.00
	Acramite	21-Aug	1 lb	$70.00	Acramite	21-Aug	1 lb	$70.00
subtotal				$97.00				$97.00
Total				**$212.00**				**$148.00**

Table 19. Seasonal trap catches of codling moths in PMA and Conventional blocks.

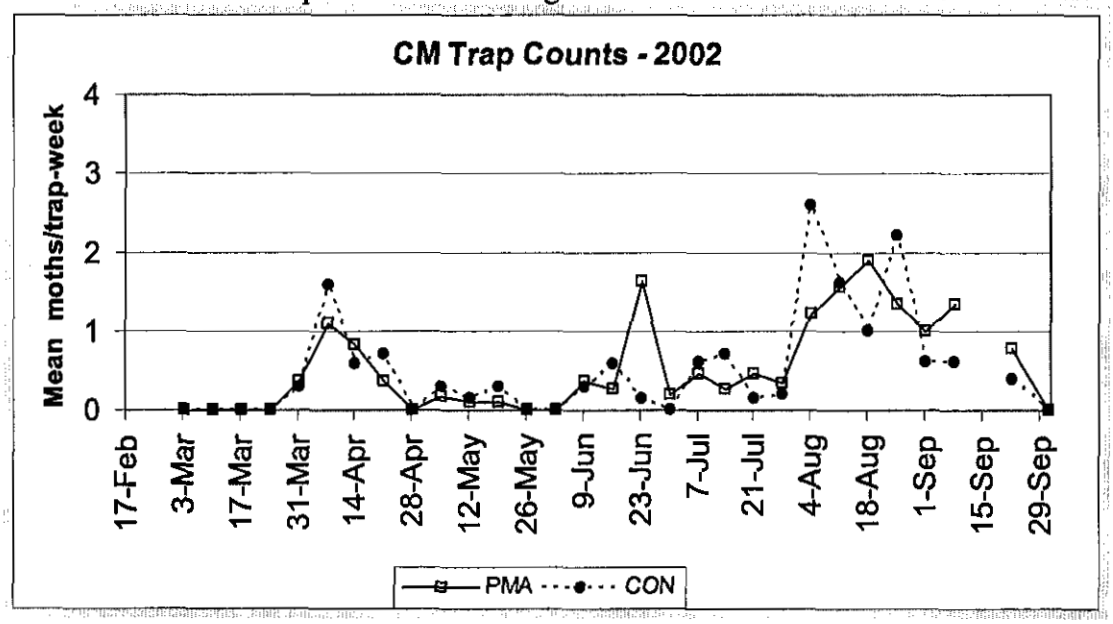
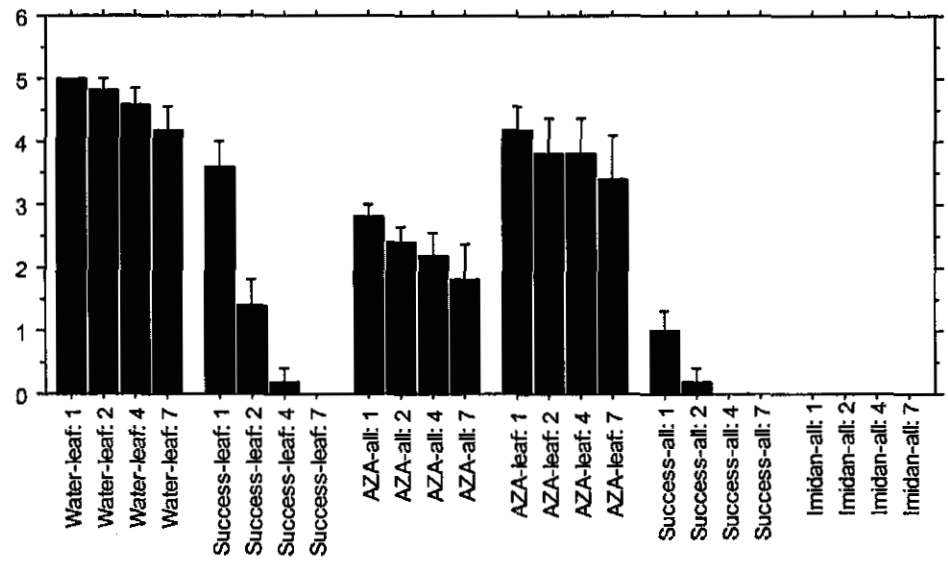
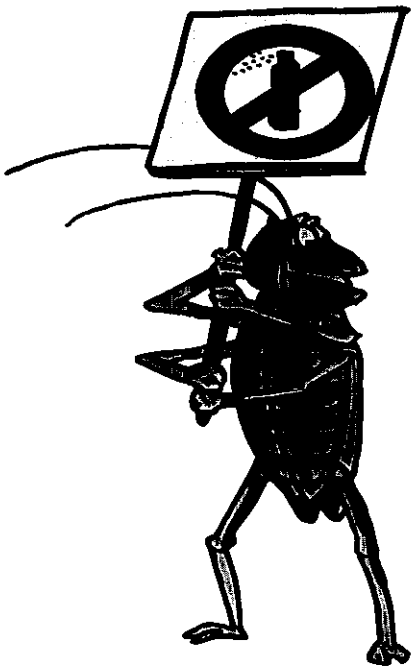


Table 20. Mean live katydid nymphs/cage, at 1, 2, 4, and 7 days after treatment Treatments: "Water-leaf" = water application to nectarine sapling only; "Success-leaf" = Success applied to nectarine sapling; "AZA-all" = AZA-Direct applied to nectarine sapling and katydids; "AZA-leaf" = AZA-Direct applied to nectarine sapling; "Success-all" = Success applied to nectarine sapling and katydids; "Imidan-all" = Imidan applied to nectarine sapling and katydids. Each cage contained five katydid nymphs; each had five replicates.





Tree Fruit Pest Management Meeting

Sponsored by the University of California, CTFA, CCPGAB, CA Dept. of Pesticide Regulation, U.S. EPA, Gowan Corp., Dow AgriSciences, Valent Corp., Suterra and Exxon Corp.

Wednesday March 13, 2002
7:30 a.m. to 9:00 a.m.

Kearney Ag Center
9240 S. Riverbend
Parlier, CA
1 Hour PCA Credit Applied For

Agenda

7:30 a.m. Registration and light breakfast

Moderator – Gary Van Sickle, Research Director, CTFA

8:00 a.m.	The Day Degree Model	Rich Coviello, UCCE Fresno Co. Advisor
8:15 a.m.	Katydid Times Three	Shawn Steffan, Research Associate
8:30 a.m.	Current Pest Situation Update	Walt Bentley, UC IPM Entomologist

A light breakfast will be provided by the California Tree Fruit Agreement at 7:30 a.m.
Breakfast will be provided only to those who register prior to March 6, 2002. Space is limited to the first 150 registrants. Please send or fax the form below to:

Attn: Amy Chelgren
California Tree Fruit Agreement
PO Box 968
Reedley, CA 93654
ph: 559-638-8260
fax: 559-638-8842

Names: _____ _____
_____ _____

Company Name and Address: _____

Phone/Fax/E-mail: _____

2002 Grower Participants: Daybreak Farms, Deniz Packing Co., Kovacevich & Sons, Gerjeet Hundal, Rubicon Orchards, Schellenberg Farms, and Tos Farms.

Tree Fruit Pest Management Meeting

Sponsored by the University of California, CTFA, CCPGAB, CA Dept. of Pesticide Regulation, U.S. EPA, Gowan Corp., Dow AgriSciences, Valent Corp., Suterra and Exxon Corp.

Wednesday April 3, 2002
12 noon to 1:00 pm

Kovacevich & Sons Ranch
Wheeler Ridge Road south of David Road
Wheeler Ridge, CA (See map on reverse side.)
1 Hour PCA Credit Applied For

Agenda

11:45 a.m. Registration and box lunch

Moderator – Gary Van Sickle, Research Director, CTFA

12:00 noon	Update on Mating Disruption	Shawn Steffan, UC Research Associate
12:20 p.m.	Current Pest Situation Update	Walt Bentley, UC IPM Entomologist
12:50 p.m.	Discussion and Questions	

Please RSVP to Amy Chelgren if you will be attending and will want a box lunch.

Attn: Amy Chelgren
California Tree Fruit Agreement
PO Box 968
Reedley, CA 93654
ph: 559-638-8260 or toll free: 800-636-8260
fax: 559-638-8842

Names: _____ _____
_____ _____

Company Name and Address: _____

Phone/Fax/E-mail: _____

2002 Grower Participants: Daybreak Farms, Deniz Packing Co., Kovacevich & Sons, Gerjeet Hundal, Ryan Metzler, Rubicon Orchards, Schellenberg Farms, and Tos Farms.

Tree Fruit Pest Management Meeting

Sponsored by the University of California, CTFA, CCPGAB, CA Dept. of Pesticide Regulation, U.S. EPA, Gowan Corp., Dow AgriSciences, Valent Corp., Suterra and Exxon Corp.

Thursday April 18, 2002
8:30 a.m. to 11:00 a.m.

Tos Farms
9th Avenue n. of Dover Avenue
Hanford, CA (Map on back)
2 Hours PCA Credit Applied For

Agenda

8:30 a.m. Registration – Coffee and Donuts

Moderator – Gary Van Sickle, Research Director, CTFA

9:00 a.m.	History of Tos Farms's PMA Orchard	Bill Tos, Tos Farms, and Les Nygren, PCA
9:05 a.m.	Utilizing Sprayables for Mating Disruption	Walt Bentley, UC IPM Entomologist
9:20 a.m.	Sampling for Katydids	Shawn Steffan, Research Associate
9:30 a.m.	Mite Sampling	Rich Coviello, UCCE Fresno Co. Farm Advisor
9:45 a.m.	Parasitoid Control of SJS	Kent Daane, UCCE Bio-Control Specialist
10:00 a.m.	Tree Nutrition	Dr. Scott Johnson, UC Pomologist and Kevin Day, UCCE Tulare Co. Farm Advisor
10:30 a.m.	Monitoring for Spotted Cucumber Beetle	Walt Bentley, UC IPM Entomologist
10:45 a.m.	FQPA - Current Tool Box Situation	Dr. Lori Berger, CA Minor Crops Council
10:55 a.m.	Discussion and Questions	

2002 Grower Participants: Daybreak Farms, Deniz Packing Co., Kovacevich & Sons, Gerjeet Hundal, Ryan Metzler, Rubicon Orchards, Schellenberg Farms, and Tos Farms.

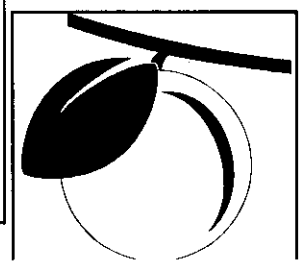
PEACH PEST MANAGEMENT FIELD MEETING

FRIDAY MAY 31, 2002, 9:00 - 10:30 A.M.

HUNDAL RANCH, GEORGE WASHINGTON BLVD & BEST ROAD
YUBA CITY (SEE MAP)

Come and learn how to economically integrate reduced risk approaches into your peach pest management programs.

Persons with special needs wishing to attend this meeting should contact the Cooperative Extension Office in advance.



- PEACH PEST MANAGEMENT ALLIANCE UPDATE AND REMARKS
  Heidi Sanders, Research Coordinator, Canning Peach Association
- ORIENTAL FRUIT MOTH (OFM) UPDATE, INTEGRATING VARIOUS MATING DISRUPTION (MD) PROGRAMS INTO OFM CONTROL PROGRAMS, NEW MD PRODUCTS AND SUMMER RESEARCH PLANS
  Janine Hasey, UC Farm Advisor, Sutter and Yuba Counties
- DYNAMICS OF OFM THROUGH THE SEASON AND COMPARISON OF OFM MONITORING PHEROMONE LURES
  Walt Bentley, UC Integrated Pest Management Advisor, UC Kearney Agricultural Center, Parlier
- TIME SAVING MONITORING FOR MITES
  Carolyn Pickel, UC Integrated Pest Management, Sacramento Valley

~ SPONSORS ~

UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION, SUTTER AND YUBA COUNTIES
UNIVERSITY OF CALIFORNIA INTEGRATED PEST MANAGEMENT
CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION
CALIFORNIA CLING PEACH BOARD
CALIFORNIA TREE FRUIT AGREEMENT

1.5 hours of PCA, Private Applicator and CCA credit are pending.

Workshop on Identification of San Jose Scale and Parasite Life Stages

Wednesday-Thursday, July 10-11, 2002

Kearney Agricultural Center
9240 S. Riverbend Ave., Parlier, CA 93648

Instructors: Beth Grafton-Cardwell, Kent Daane, Rich Coviello and Walt Bentley

Course Objective: To teach Pest Control Advisors and growers how to recognize the various life stages of San Jose scale and their parasites, to predict major events in their lifecycles using degree day units, and to estimate the severity of the infestation and the level of biological control in the field. With this knowledge PCAs and growers make better decisions about scale control tactics in deciduous orchards.

Tuesday

7:30-8:00 a.m. Registration - Kearney Agricultural Center
8:00-12:00

- Lecture - Beth Grafton-Cardwell: Life stages of San Jose scale
- Microscope: Identification of scale stages, including molts and instars as well as differentiation of males and females using laboratory reared scale

12:00-1:00 Lunch (served at Kearney)
1:00-3:00 p.m.

- Lecture – Kent Daane: Biological Control of San Jose Scale
- Microscope: Identification of parasitism by *Aphytis melinus* and *Encarsia pernisciosa* in San Jose scale
- Identification of scale and parasites using field collected twigs
- Quiz on scale stages and parasitism

Wednesday

8:30-12:00

The use of degree day units to 12:00

- Lecture – Rich Coviello: Degree day units and how to use them to predict significant events in the San Jose scale lifecycle
- Lecture - Beth Grafton-Cardwell: problems with insecticide resistance
- Lecture – Walt Bentley: How to manage San Jose scale with oils and natural enemies

12:00 – 1:00 Lunch (served at Kearney)
1:00-3:00 pm

- Field – Walt Bentley: Visit a nearby orchard and examine trees for San Jose scale populations and discuss how to recognize an economically damaging level of scale.

Cost of the Workshop is **$25** (including lunch and classroom materials). Class size is limited to 30 participants so early sign-up is recommended. Sign up by **July 5** with Lois Strole at (559)

646-6545, Kearney Agricultural Center, 9240 S. Riverbend Ave., Parlier, CA 93648. A check will reserve your place in the class and **checks are made payable to the UC Regents**. We request that participants bring a hand lens and 5-10 scale-infested twigs from their own orchards to the class. PCA credits will be requested.

****This workshop is being sponsored by California Tree Fruit Agreement****

Reprinted from CTFA's July Research Newsletter:

Katydid Management in Stone Fruit

Contributed by Shawn Steffan, University of California
Davis, stationed at the Kearney Agricultural Center (ssteffan@uckac.edu) 559-646-6500.

In the San Joaquin Valley, katydids are becoming perennial pests of stone fruit production, particularly in nectarine orchards. The predominant species is the fork-tailed bush katydid. Nymphs and adults feed directly on the fruit, causing substantial yield loss. Control over the years has generally occurred incidentally as other pests in the orchard were targeted with various organophosphates and carbamates. The typical dormant-season application of chlorpyrifos (Lorsban®), for example, likely kills katydid eggs, and in-season applications of phosmet (Imidan®) is thought to reduce nymphal and adult populations. In recent years, the use of organophosphates (OPs) has declined as reduced-risk insecticides have become more widely used.

The decline in the use of OPs may be attributed to insect resistance, effective alternatives, and the recent Food Quality Protection Act (FQPA). The FQPA regulations mandate that all OPs be re-registered by 2006, and it is anticipated that certain materials will be lost at this time. Non-OP materials (e.g., pyriproxifen, Bt, spinosad, pheromone mating disruption) have proven to be effective alternatives for certain pest species, but pests such as katydids require a "clean up" treatment. For growers and PCAs seeking reduced-risk approaches to katydid control in stone fruit orchards, additional efficacy information on reduced-risk materials is needed.

A study conducted this spring compared how well azadirachtin (AZA-Direct®), spinosad (Success®), and phosmet (Imidan 70-W®) could reduce nymphal katydid population numbers. Azadirachtin and spinosad are considered to be reduced-risk materials because they are relatively short-lived and less toxic to non-target organisms. AZA-Direct, Success, and Imidan were chosen because they are registered products in California nectarines. Various growers, PCAs, and farm advisors have indicated these materials are often effective on katydids, but rates per-acre and precise efficacy information has not been available. Although Imidan is an OP, it was included to provide a benchmark for comparison with the other insecticides.

Results: The reduced-risk material Success suppressed katydid populations almost as well as the Imidan, though it required an extra day to do so. AZA-Direct showed promise but did not perform as well as Success. Despite a slightly higher count in the reduced-risk blocks, the degree of katydid suppression was quite good, and in terms of acceptable efficacy for growers, the reduced-risk materials appear to be viable alternatives. AZA-Direct is thought to function as an Insect Growth Regulator (IGR), an anti-feedant, and as a sterilant for females. These field trials were conducted this spring when katydids were 3rd and 4th instars. As they grow, it appears they become more resilient and may not be as effectively suppressed with a given material. For this reason treatments for katydids in the spring are critical.

Percentage of katydids alive 1 week after application.

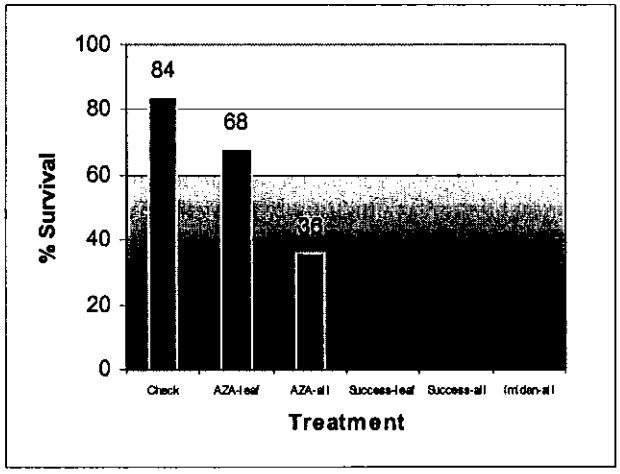


Exhibit 6

INFORMATION ON RESEARCH SUPPORTED BY THE CALIFORNIA TREE FRUIT AGREEMENT

October 10, 2002

Contact: Gary W. Van Sickle, Research Director
gvansickle@caltreefruit.com

Pest Management (PMA) Project Update

Contributed by Shawn Steffan, University of California
Davis, stationed at the Kearney Agricultural Center (ssteffan@uckac.edu) 559-646-6500.

Harvest data for this past season show very similar results across all blocks. Overall, the PMA blocks appear to have produced approximately 90% marketable fruit, and the conventionally managed blocks appear to be approximately 1-2% higher. Examining the season-long fruit quality, derived from weekly fruit ratings, it is clear that differences between PMA and CON blocks were slight. These results reflect the findings of last year, and represent the third year in a row that growers using reduced-risk materials and IPM techniques produced fruit of similar quality and quantity to conventionally managed acreage.

While fruit quality was similar between PMA and conventional blocks, the typical signs of insect activity were generally higher in the PMA blocks. The indicators of insect activity are shoot strikes, leaf feeding, and mite presence on leaves. Across all blocks, there were generally more strikes, mites, and leaf feeding. This is the third year that this phenomenon has been noted, and it seems that the activity is a reflection of generally higher insect populations, but these populations do not necessarily impact yield. In fact, it is important to recognize that beneficial insects require pest insects as a food source, and in order to maintain a balance between predator and prey, both groups of insects need to be present.

The seasonal dynamics of Oriental fruit moth (OFM) and San Jose scale (SJS), which are two of the more critical perennial pests, were markedly different from previous years. In the past, SJS counts were typically much higher in the PMA blocks, as were the associated scale parasitoids. This year more SJS have been found in the conventional blocks, and substantially more parasitoids, as well. The mean number of scale in the conventional blocks is more than twice that of the PMA blocks. It may be that the scale populations in the PMA blocks are in general decline due to the effects of parasitism and reduced-risk insecticides. Growers who spray high rates of horticultural oil each winter, instead of organophosphates or carbamates, preserve much of their parasitoid population and thereby keep the scale population in check during the spring and early summer. Late-season problems can emerge, however, as the parasitoids become less synchronized with the scale population.

In previous years the OFM numbers have been lower in the PMA blocks due to the use of mating disruption. However, this season, almost twice as many OFM were caught in PMA blocks. Part of the reason for this is that several growers used mating disruption on their conventionally managed acreage because it is so effective. Also, the fact that mating disruption operates over a broad area makes it difficult to keep the material out of non-disrupted blocks that are adjacent to disrupted blocks.

The most noteworthy aspect of this season has been the high katydid populations observed in the orchards. Most were the fork-tailed bush katydid, though one block had mostly angular-winged katydids. Damage due to katydids was mild, overall, but some blocks had pre-thinning damage counts around 10-15%. Success® was applied at most of the PMA blocks by mid-April, and the conventional blocks had either Sevin® or Imidan® applied. All katydid

populations were effectively suppressed. Growers, where possible, waited to time the katydid application with the optimal "window" for OFM or PTB. Katydid damage was low and essentially equal between the PMA and Conventional blocks.

Additional information regarding katydids has just come forward from this project. Young fork-tail bush katydid nymphs were found in a cage study in mid-August and are known to have hatched from eggs laid in June. Until now, it was not known if katydids were limited to one generation per season, or more. It was known there are two hatches per season, one in June and one in August. There had been speculation that the hatch in August was from eggs laid the previous year. This information indicates that good control efforts in the early season for katydid should serve to reduce the population that hatches in August.

The next PMA Workshop will be held on Tuesday November 5, 10:00 a.m. at the KAC in Parlier.

Online Filing for Pesticide Reports

Growers and pesticide applicators can save time and money by filing online applications directly to their County Agricultural Commissioner's Office through eWorldAg. Their web address is www.eWorldAg.com. The "Apps on Tap" service allows the filing of required forms, such as pesticide use reports, monthly use reports and notices of intent online and at no cost. Reports may also be saved on file or printed out for personal record keeping. Additional information is available from Karri Hammerstrom, 559-485-3928.

Fall/Winter Disease Management Practices for Peaches and Nectarines

Contributed by Dr. Jim Adaskaveg, University of California
Riverside (jim.adaskaveg@ucr.edu)

A number of diseases need to be managed during the fall and winter period. Cultural practices such as sanitation are important for brown rot where after-harvest fruit and mummy removal needs to be effectively practiced. Peach leaf curl and shot hole are also managed with orchard sanitation by pruning away diseased branches. In addition, fall, dormant, or delayed dormant applications of copper, copper/oil, dimethyl dithiocarbamates (e.g., ziram) or chlorinated hydrocarbons (e.g., chlorothalonil) are highly effective treatments that have been used for a long time. Although the use of dormant copper applications for bacterial blast is questionable, treatments are sometimes utilized. The potential of rust and powdery mildew to cause problems in the following spring and summer can be monitored during the fall season. For example, high levels of rust in the fall are indicative of a high risk for rust in the following spring. Powdery mildew has been on the increase in recent years. Cleistothecia, the overwintering stage that contain the sexual spores (i.e., ascospores), have been found on peach and nectarine for the first time in recent years during the dormant period. Fall or delayed dormant (pre-bloom) applications of sulfur or liquid lime sulfur have been effective on cherry for reducing overwintering inoculum of the cherry powdery mildew pathogen. These treatments need to be assessed on peach. Phytophthora crown and root rot can be a problem in years in orchards where flooding occurs. Use of mefenoxam (metalxyl) for bearing and non-bearing trees or fosetyl-aluminum for non-bearing trees only may be beneficial for managing this disease.

Weed Control during a Drought

By Harold Larson (Harold.Larson@Colostate.edu)

During drought years growers should think about weed control, as these compete with the trees for water and nutrients. A wet weather pattern will provide a good opportunity to do a post-harvest application of pre-emergent herbicides for weed control. Precipitation will move the herbicides down into the soil profile where they will be effective in controlling seed germination. Application before leaf fall will get them to where they need to be before the fallen leaves can block that route.

Remember that the area to be treated is not the same as the block acreage; it usually is a smaller portion of the block acreage. The recommended rates are based on the area actually treated.

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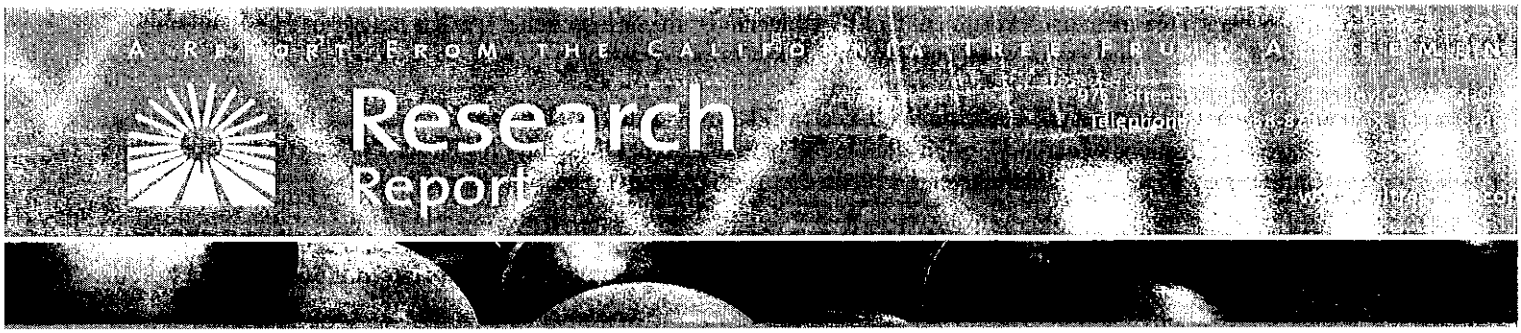

INFORMATION ON RESEARCH SUPPORTED BY THE CALIFORNIA TREE FRUIT AGREEMENT

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Research Director

Contact: Gary W. Van Sickle,

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Practices for Protecting Surface Water

(Compiled from "Orchard Practices for Protecting Surface Water" published by Coalition for Urban/Rural Environmental Stewardship, phone: 916-646-9951 or on-line at www.curesworks.org.)

Listed below are guidelines to orchard management practices that show potential for reducing pesticide runoff from orchards following dormant season applications. Some are proven techniques demonstrated to be effective in California agriculture, while others are currently being studied. On any given farm site, some practices may perform as intended while others could be limited in effectiveness and practicality by crop, land gradient, soil types, local cropping patterns and pest populations. The practices discussed below will fall into two categories: Pest management strategies and On-site practices for runoff reduction.

From a pest management perspective, the best time for organophosphate (OP) pesticide applications is during the dormant season. Dormant applications were originally recommended, in part, to help reduce environmental impacts, damage to pollinators and predator insects and reduce in-season worker exposure and pesticide applications. However, OP pesticide applications during the rainy dormant season carry certain environmental risks. OP pesticides are routinely detected in the San Joaquin, Sacramento and Feather Rivers following dormant spray applications during and after mid-winter storms.

Viable alternative strategies to OP pesticides are those which offer favorable levels of pest control efficacy, are effective in reducing the risk of aquatic toxicity and are comparable in cost to conventional OP pesticide dormant sprays. A viable strategy could also be used for OP pesticides with proper

mitigation measures in place that prevent offsite movement. Viable pest management strategies do exist that can reduce or even eliminate the amount of OP pesticides applied during the dormant season.

It's important to note that any pest management practice, including dormant OP pesticide applications, should include close monitoring of orchard pest populations for success. The cost of pest monitoring can vary, but may increase the overall cost of pest control by $20 an acre. However, savings in pesticide costs may offset the cost of pest monitoring.

• Dormant Diazinon and Oil Spray. When using diazinon, use appropriate on-site practices and application methods to reduce potential for off-site movement. Each orchard has a range of potential contributions to runoff and associated aquatic toxicity based on orchard site characteristics (soil type, slope, proximity to water bodies, etc.). Alternate with non-OP pesticides to prevent resistance from developing to either diazinon or non-OP pesticides.

• No Dormant Treatment or Dormant Oil Only Treatment. Dormant insecticide spray is not applied or an oil only treatment is made. Successful when pest pressure is low or non-existent.

• Alternate Year Dormant OP Pesticide With Yearly Oil Spray. Additional in-season treatments for mites following in-season applications of carbaryl, esfenvalerate and permethrin (peaches only) for Peach Twig Borer in peaches and nectarines may be necessary during years with no dormant OP spray in the Sacramento Valley.

• Dormant Spray With non-OP Pesticides and Oil. Apply pyrethroids, permethrin (peach only) and esfenvalerate, and carbaryl in the dormant or delayed-dormant season. OP pesticides should be considered if dormant spur monitoring indicates moderate to high San Jose scale populations.

• Spinosad and Oil as the Dormant Spray. Spinosad (Success®) is a low-risk pesticide for control of peach twig borer. However, it is not effective for San Jose scale during dormancy.

• Bloomtime Sprays of Bacillus thuringiensis (Bt) to control over-wintering Peach Twig Borer. Bt will not control San Jose scale.

• Pheromone Mating Disruption for Peach Twig Borer and Oriental Fruit Moth. Mating disruption cannot be considered a stand-alone system. It is selective for the targeted pest so monitoring for other orchard pests is necessary.

On site practices for runoff reduction include:
• Maintain orchard floor vegetation during the dormant season. These can be seeded or resident vegetation growing on orchard floors that are later mowed or disked.
• Plant large-seeded or small-seeded winter annual cover crops. Examples include cereal grains, legumes, clovers, and fescue grasses.
• Plant vegetative filter strips. These strips should be located between crop fields and water bodies.
• Riparian buffers may be formed by planting trees and shrubs adjacent to streams. Forest type buffers are frequently combined with an understory of perennial grass buffers.
• Hedgerows, fences of shrubs or trees, located in, across, or around a field can provide drift mitigation by potentially reducing off-site movement of pesticides.

For copies of the publication call 916-646-9951.

Bees and Pollination Issues

Now is the time for growers to be thinking about coordinating their beehive needs for the bloom period. Here are some suggestions from beekeep- pers to help get the most from the bees.
1. Growers should not water during the bloom or at least during 7 days of it, as the water will serve to cool the air in the orchard.

2. When putting hives inside the orchard, put hives in an open area where they will not be shaded during the day. For smaller blocks the hives should be outside of the orchard in the open.

3. Select hives which are on a pallet painted black and which has an entrance to the hive that has been painted black.

4. Don't spray during the day when the bees are flying. It is better to spray early and late in the day, or at night.

5. Place hives at the southeast side of trees to get morning sunlight on them.

6. Don't face hive to the north. If hives are on a pallet with openings at opposite ends, try to face east-west or northeast-southwest direction. Best is to face hive openings to the south.

7. Don't position hives too close to other hives. Bees can recognize their own hive better if there is not a lot of hives grouped closely.

It is important for the grower and his beekeeper to communicate on these issues. For some commodities the cost of bee hives can contribute 5-10% of the cultural costs. More detailed information is available at http://gears.tucson.ars.ag. gov and click on "online pollination handbook".

Receive this Newsletter via Email

This research newsletter can now be direct e-mailed to those who request this service. If you wish to receive this please fax (559-638-8842) or email your request to Amy DeMoss at ademoss@caltreefruit.com. Please include your name, company and email address with your request.

Article in May Issue of The Grower Magazine

A softer side of pest control

Demonstration hopes to show stone fruit growers that non-disruptive techniques pay

By Vicky Boyd
Editor

Exhibit 9

Ever since Robert Jackson was first introduced to mating disruption for apple codling moth in the late 1980s, he has slowly been easing into a softer approach with his stone fruit pest control.

Although the program, which relies on non-disruptive pesticides, dormant oil sprays, mating disruption and beneficial insects, is not a silver bullet, the Tulare County, Calif., area fruit grower believes it is the future.

" Half of me really enjoys farming this way—working with creation rather than against it," Jackson says. " The other half believes we will see the elimination of most of the OPs (organophosphates), and I want to be a step ahead of the curve.

" I' ve always taken the approach, and still do today, that if I come across an economically damaging level of any insect, I will spray. That is the bottom line because I can' t risk my farm."

Jackson isn' t alone, either. Already, two out of three California stone fruit growers are using some type of reduced-risk materials or practices, according to a recent California Tree Fruit Agreement (CTFA) study.

But a group calling itself the Pest Management Alliance wants to take the practices to the next level.

Through a collaboration of growers, University of California Cooperative Extension, the California Department of Pesticide Regulation, CTFA and the California Cling Peach Board, the alliance is comparing participants' standard pest-control program to a softer approach in side-by-side demonstrations. The U.S. Environmental Protection Agency also is helping fund the program.

The PMA approach is not intended to replace all OPs, but rather to demonstrate that viable alternatives exist and can be successfully incorporated into the pest control arsenal, says PMA coordinator Shawn Steffan, who works at the Kearney Agricultural Center near Parlier, Calif.

The use of OPs, carbamates and pyrethroids certainly can be reduced in California stone fruit orchards, he says, but it is up to growers and pest control advisors to make the effort to do so.

In the end, alliance members want to show other growers that a reduced-risk approach is agronomically feasible, says Gary Van Sickle, CTFA research director in Reedley, Calif.

The program will run for at least four years to account for environmental variables that could affect pest pressures.

" One of the criticisms by growers is, ' you can do it for a year or two, but can you do it for a longer period of time?' " Van Sickle says. " We want to do this over a certain length of time to show them they can do it."

Putting it to the test

During the 2001 growing season, Jackson and six other growers with 12 peach, plum and nectarine varieties in the San Joaquin Valley and one grower with seven peach varieties in the Sacramento Valley participated.

In the San Joaquin Valley, the PMA approach involved using 8 gallons of horticultural oil in 400 gallons of water for dormant control of San Jose scale.

During the growing season, spinosad (Success) was used around petal fall for thrips, mating disruption for Oriental fruit moth, in-season applications of *Bacillus thuringiensis (Bt)* and/or spinosad for OFM, peach twig borer and/or katydids. The program also included optional late-season applications of methomyl (Lannate) or phosmet (Imidan).

You can bank on it

Through two years of the demonstrations, the average costs and fruit damage for the San Joaquin Valley blocks are comparable.

But in the three blocks of canning peaches in the Yuba County area, the PMA blocks averaged about $161 per acre compared to about $50 for the conventional blocks in 2001.

Janine Hasey, a UCCE farm advisor for Yuba and Sutter counties, says the area

growers' heavy reliance on less-expensive pyrethroids is a reason for the cost disparity.

The participating grower used mating disruption early in the season, then returned with one or two pyrethroid sprays later. A season-long pheromone program could run as high as $100 per acre alone. Canning peaches also tend to ripen later in the season than some of the early- and mid-season fresh-market varieties, exposing them to increased pest pressure.

Nevertheless, Hasey says the program is still weaning growers away from the harsher OPs and carbamates.

" If you don' t put on additional pheromones and come back and spray with a pyrethroid, you are still reducing the pesticides, just not as much," she says.

In addition, the participating grower didn' t have a mite problem during the 2001 season and didn' t have the miticide costs that many of the area' s other conventional growers did. That would have put the conventional cost at about $100 per acre.

A mind-set change

Jackson has been able to control OFM using only mating disruption on his early varieties. On the later varieties, he' s used a combination of mating disruption and sprays, such as phosmet, which are easier on the beneficials. For PTB, he uses two applications of *Bt*.

In the end, the pest control costs over his entire 300 acres of stone fruit balance out.

" Mating disruption cost me more on the early fruit, but it reduced the pressure and the amount of spraying that I had to put on my late fruit," Jackson says.

A need for vigilance

Because the PMA program relies on several pest control products with a narrow application window, Steffan says PCAs and growers have to be vigilant about pest monitoring.

Take a *Bt* or spinosad product, for example. Both materials have about a one-week residual compared to the much longer-lived OPs, carbamates and pyrethroids, Steffan says.

Day-degree models, available on the Internet, let growers and PCAs know the growth stage of insect populations so they can target pesticide applications when they' ll be most effective.

Jackson agrees and says one of the keys is the PCA.

" You definitely have to have a good PCA monitoring things," he says. " You either need to be the expert or the PCA you work with has to be very familiar with the approach."

Jackson also doesn' t advocate switching suddenly from conventional practices to the softer approach. Instead, he suggests easing into the program so you can learn how each technique works and build your comfort levels.

Unexpected visitors

One unexpected problem some growers have begun seeing is an increase in secondary pests, such as the fork-tailed bush katydid, Steffan says.

In the past, the dormant or in-season OP sprays controlled the pests. Without the OPs, however, the pests are becoming more of a problem.

Jackson has learned to watch the grassy middles in his orchards for hatching katydids. In the younger life stages—up to fourth instar—the pest can be controlled with spinosad. When the nymphs are still small, the Tulare County grower sprays the ground cover. He has even experimented with neem oil in mid-summer on adults with some success.

" You have to keep constant vigilance," Jackson says. " It seems that we run into something every year, but I feel we have made progress." G

Table 21. Selected OP & Reduced Risk Chemicals – Pounds A.I. Used

NECTARINES

Chemical	Trade Name	1997	1998	1999	2000	2001
Azinphos Methyl	Guthion	841	506	915	1,598	634
Bt	Dipell	2,091	2,867	2,288	1,915	1,782
Chlorpyrifos	Lorsban	17,758	21,105	21,704	35,177	23,104
Diazinon		37,493	21,071	17,217	17,596	13,842
Formetanate Hydrochloride	Carzol	37,529	39,805	38,225	30,861	27,108
Methidathion	Supracide	16,497	6,196	6,776	3,716	2,405
Phosmet	Imidan	22,917	27,378	39,515	26,695	61,474
Spinosad	Success	0	0	8	1,966	1,471

PEACHES

Chemical	Trade Name	1997	1998	1999	2000	2001
Azinphos Methyl	Guthion	2,806	1,066	1,376	2,095	1,637
Bt		2,112	2,163	2,281	1,892	2,105
Chlorpyrifos	Lorsban	14,537	22,239	23,200	30,871	29,058
Diazinon		61,393	36,905	30,247	35,101	33,056
Formetanate Hydrochloride	Carzol	972	1,785	1,179	621	295
Methidathion	Supracide	24,364	12,225	12,328	13,504	7,386
Phosmet	Imidan	39,103	53,864	54,967	45,443	79,477
Spinosad	Success	0	0	38	1,642	829

PLUMS

Chemical	Trade Name	1997	1998	1999	2000	2001
Azinphos Methyl	Guthion	1,513	1,058	963	1,521	1,298
Bt	Dipell	1,120	2,584	1,107	1,096	785
Chlorpyrifos	Lorsban	15,291	18,354	20,321	20,217	20,434
Diazinon		29,422	15,520	14,094	12,651	12,586
Formetanate Hydrochloride	Carzol	822	634	396	537	186
Methidathion	Supracide	21,756	13,250	11,831	10,568	7,981
Phosmet	Imidan	25,736	20,186	24,418	23,677	26,622
Spinosad	Success	0	0	117	724	912

Source: DPR-Pesticide Use Report Data